The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	433
Wireless and the Atmosphere	434
The Tone Control Transformer	436
Hints and Tips	438
Current Topics	439
Listeners' Guide to the Jubilee Broadcasts	440
LF Amplification in Television Receivers (concluded)	444
High Fidelity and the Set Designer	446
AC Short-wave Converter Tested	447
Broadcast Brevities	449
Unbiased	450
Foundations of Wireless XX	451
Random Radiations	453
Letters to the Editor	454
Principal Broadcasting Stations	455

Editorial Comment

Jubilee Week

THIS week of Silver Jubilee celebrations will provide a memorable and inspiring climax to the splendid economic and social achievements standing to the credit of Great Britain after anxious periods magnificently surmounted. Had the same set of circumstances occurred some twenty or even fewer years ago the nation would have been thrilled. But the complete absorption of the whole of the people into one united family surrounding the Throne would not have been possible then, in the absence of broadcasting, as it is to-day.

To-day, thanks to the universal use of wireless, and thanks also to the British Broadcasting Corporation for having established not only a complete broadcasting service throughout the mother country, but also a short-wave broadcast distribution, the whole Empire is simultaneously informed of all that is happening this week in the heart of the British commonwealth of nations.

No matter where Britons may be found, Buckingham Palace, St. Paul's and the great thoroughfares of the Metropolis will be brought before them by the agency of broadcasting. Throughout the far-flung Empire, in the very remotest parts of the earth, the subjects of the King will be able to take an intimate part in the Pageant of the Silver Jubilee as it unfolds itself before those who can be actual eye-witnesses of it.

Nothing could provide a more striking demonstration than this of the value of an invention, that it should have done so much to weld the British peoples into one closely knit family.

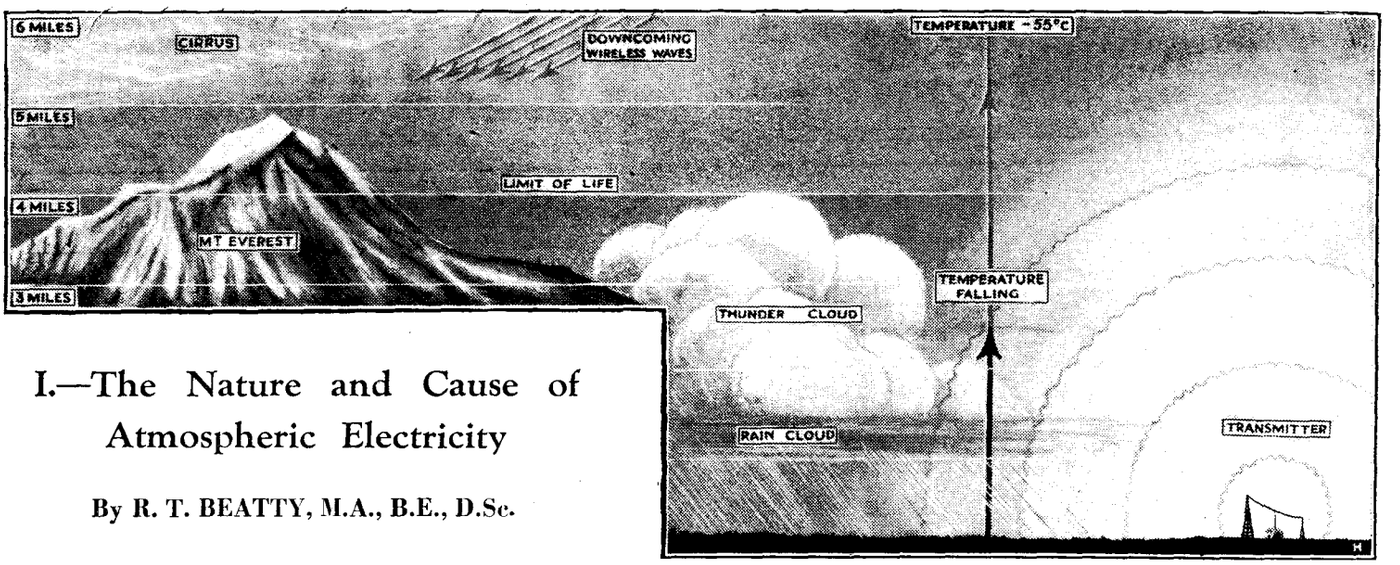
His Majesty, whose twenty-five years of beneficent sovereignty we acclaim this week, is himself a broadcaster. By means of wireless King George's voice has reached the ears of millions of his subjects, and it is but bare truth to say that no broadcast is ever awaited with such eagerness and expectancy as His Majesty's annual greeting to his peoples on Christmas Day.

May he long be spared to repeat again and again that heartening bond made possible by wireless between the Royal House and the homes of his subjects.

Programmes

JUST as Jubilee Week is an outstanding event in the lives of every one of us so is it a week of great undertakings and responsibility for the B.B.C. The task which the Corporation has set itself to do in order to enable this country, the Empire, and the world to participate in these celebrations will exact a high degree of efficiency even from so well organised a system already accustomed to big achievements in broadcasting topical events. The Outside Broadcast Department of the B.B.C. in London will have one of the busiest weeks on record. No less than eighty-four microphones will be in use and eighteen control units. The B.B.C. estimates that 5,200 yards of cable will be used for connecting up the microphones and there will be a thousand terminal connections to make. Elsewhere in this issue we devote special pages to giving our readers a general guide to what is being provided in the way of special programme items.

Wireless and the Atmosphere



I.—The Nature and Cause of Atmospheric Electricity

By R. T. BEATTY, M.A., B.E., D.Sc.

THE purpose of this series of articles is to explain in a simple way the various factors which affect our reception of wireless signals. Chief among these factors is the atmosphere, whose many layers, sensitive as they are to the influence of solar radiation and to invaders such as meteors, cosmic rays, and electrified particles of all kinds, control reception at medium and long distances. Indeed, our knowledge of the upper atmosphere, in those rarefied regions which man can scarcely hope to reach, is chiefly due to wireless waves, which, as they return bent and twisted to earth, reveal the story of their adventures in the high sky a hundred miles above us.

IT is now well known that the successful transmission of wireless waves over long distances is due to a strange series of events which takes place in the upper reaches of the great ocean of air which is flung around the earth.

The air which we breathe and explore in balloons and aeroplanes has no influence on wireless waves. It is transparent to them just as it is transparent to the light of the sun or to the cosmic rays which stream in from outer space and pass through unhindered. Save for transient disturbances due to lightning and to the effects of electrified drops of rain falling upon aerials, our reception of wireless programmes is unaffected by the atmosphere at these low levels.

But high in the sky, far above the highest level to which a balloon has ever carried a human being, lie the regions which have a profound influence on the path of wireless waves. From fifty to a hundred miles above our heads, where the air is so thin that the most delicate barometer would fail to detect its pressure, and where molecules of gas are so few that one of them may travel for a mile before colliding with another, there are layers of intense electrification which serve to prevent the escape of all except the very shortest waves.

Two of these regions are more permanent than the others. The lower one is the Heaviside layer, and fifty miles farther up lies the Appleton layer. Though permanent in the sense that they never fade away completely, we must not think of them as rigid and burnished mirrors set in the sky. We may with greater truth regard them as tides in the high atmosphere, waxing and waning as the earth turns between day and night, varying with the phases of the moon, sensitive to those gigantic solar convulsions which appear as sunspots, and appreciably disturbed by the showers of meteors which from time to time invade the upper air.

The behaviour of these layers is, as we shall show, largely dependent on events which take place far below in the lower regions of the atmosphere, and since the lower regions are also the seat of disturbances which are of great importance to radio workers it seems worth while to begin at the surface of the earth and try to explain, as we travel farther and farther upwards, the somewhat surprising discoveries which have been made of late years in the domain of meteorology regarded from a radio point of view.

The title illustration gives a pictorial representation of the troposphere, the lowest of the layers of the atmosphere. In it are generated practically all the atmospherics which trouble wireless reception, for it is only in this region that air is dense enough and winds strong enough to cause intense electrical discharges. A typical summer thundercloud is shown with its accompaniment of lightning and electrified rain. On the ground we must imagine the wireless station as competing with the noises from unsilenced electrical machines of all kinds. This region is filled with wireless waves pouring along the surface of the earth and forming a wireless atmosphere which is densest in the troposphere.

The Troposphere

The lowest layer, the troposphere (the word means a region of movement), is the domain of wind and rain, and of clouds and thunderstorms. It extends upwards to a height of about six miles and so surmounts the tops of the highest mountain peaks. In this region the air becomes steadily colder with increasing altitude, the fall in temperature amounting to about 9 deg. C. per mile, so that at the upper boundary of the troposphere the thermometer may read −55 deg. C., a degree of cold as intense as is ever reached in Polar regions on the earth's surface. At this temperature all known liquids are frozen, mercury included. This coldness is at first thought surprising, for at an altitude of six miles the sun's rays have an intensity greater than at the earth's surface, since they have not yet suffered absorption by the clouds which lie below, and, indeed, Piccard in his balloon ascent to a height of ten miles found that the sealed metal car in which he was enclosed became uncomfortably hot.

But air differs from metal in being practically transparent to solar radiations except for the small fraction which extends into the far intra-red spectrum, and since a body can only grow hot by absorbing

Wireless and the Atmosphere—

energy the intense radiation which pours down fails, even on the equator, to warm the air through which it passes. Hence it is the surface of the earth and not the air which is heated by the direct rays of the sun.

It is from this heated surface that the layer of air just above receives warmth, both by direct contact and from the long-waved heat rays emitted by the earth, which, unlike the shorter waves comprised in sunlight, are readily absorbed by air.

The Invisible Man

While on this subject we might make a scientific prediction concerning the Invisible Man described by Mr. H. G. Wells. Since this unfortunate creature was perfectly transparent he could never enjoy the warmth of sunlight but must have relied on transmission of heat by contact to his body from the surrounding air and the ground on which he trod.

The warmed air expands and rises owing to its increased buoyancy. As it ascends into more rarefied regions it cools both on account of its continuing expansion and because it radiates away its heat; this loss cannot be made good by absorption, at least, not until its temperature falls to about −55 deg. C., for, as we have already pointed out, the absorptive power is small. And so within the limit of the shell of gas called the troposphere there is a steady fall of temperature with increase in elevation.

The radio worker has good reason to consider the troposphere as the home of unwanted radio signals, which are due largely to lightning and to a smaller extent to electrified rain. Rain, fortunately, is strictly local in its effects, and is only electrified if it has fallen through a turbulent atmosphere, but the atmospherics which plague us nightly reach our aerials from thunderstorms up to distances of a thousand miles away. Let us consider the cracklings and mutterings which at times disturb our enjoyment of the gentle music of Schubert as faint echoes from gigantic and brutal Wagnerian compositions roaring over mid-Europe or far out in the Atlantic, and we may then regard them more tolerantly.

Thunderstorms and Wireless

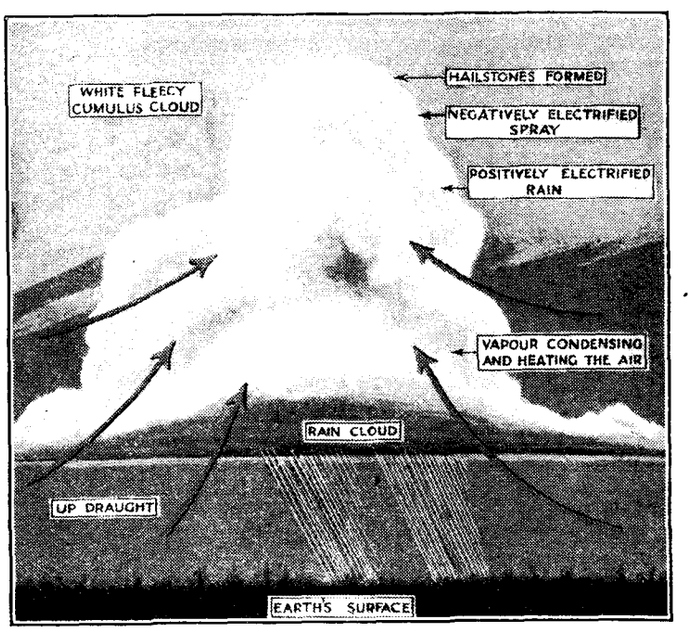
Few people realise how enormous is the power emitted in a thunderstorm or the reasons for the production of the considerable charge of electricity accumulated prior to its discharge as a flash of lightning.

It is not easy to electrify raindrops. Dr. Simpson, in his attempts to produce a thundercloud in the laboratory, found that no electrification was produced by freezing drops of water or by thawing the resulting hailstones, or by friction of falling drops against still air. But when air was blown upwards against the drops so that the relative speed exceeded twenty miles an hour, spray was torn off and the upward-carried spray was charged negatively, while the drops were left behind with a positive charge. Thus, an upward blast of air of sufficient intensity acts as a kind of Wimshurst machine, generating electricity as long as rain is falling. Now, upward air currents of this kind obviously occur in cumulus clouds, those white, massive, towering structures which are thunderclouds *par excellence*. For the summit of the cloud is often observed to be in violent motion and to be blown out like the head of a cauliflower. Moreover, the hailstones which frequently occur in thunderstorms must originate as raindrops which, after their formation, are carried up to higher and colder altitudes where they freeze, and to carry an average hailstone upwards an air blast at twenty miles an hour is required.

So far, then, the explanation of the working of the great electric generator is acceptable. The next question is, Whence comes the vertical draught?

Imagine a hot, still afternoon when the warmed surface air is drifting gently upwards. Over a moist region the air is more heavily charged with water vapour than over the surrounding drier surface, but in any case the air as it rises enters colder and colder altitudes. At a height of, say, a mile, the moist air becomes cooled to a point where its water vapour reaches saturation and begins to condense as a fine rain. Now, as steam engineers know well, when vapour condenses heat is given out—the latent heat of steam—to such an amount that for every pound of water formed enough heat is produced to raise five pounds of water to boiling point.

This heat, produced by condensation, has a profound effect on the behaviour of the column of moist air—the cumulus cloud. For the heated air becomes more buoyant than air at the same level outside the cloud, and wind begins to rush into the cloud from the regions outside and from below. Here, then, is the origin of the updraught which, like air ascending in a heated chimney, blows up along the core of the cumulus, and attains enough speed to disrupt and electrify the falling rain.



Events in a thundercloud, the most potent source of atmospherics.

The Thundercloud Dynamo

The numerical figures relating to thunderclouds are of startling magnitude. In five seconds a charge of 20 coulombs (equivalent to 4 amperes flowing for five seconds) may be carried up by the ascending spray, thus forming an electric condenser with an upper negatively charged plate and a lower positive plate formed by the positively charged raindrops or by the earth below. In thirty seconds the potential difference may amount to five thousand million volts, whereupon a flash occurs. The thundercloud machine keeps on generating electricity at this high pressure, and if we reckon on a flash every thirty seconds we arrive at a figure of the average horse power of the stupendous value of four million horse power. Compare with this the performance of the great Battersea power station which (if its third steam turbine has been installed at the date of writing) is capable of 300,000 horse power. One thundercloud equals thirteen Battersea stations! Or consider that one H.P. = the power of six men, but, since a man can only work at this rate for six hours per day, while a machine works continuously, one H.P. = twenty-four men, and since including women and children only one individual out of four is capable of this work, one H.P. = ninety-six individuals. Accordingly, one thundercloud machine = 4×96 million individuals, so that the total man power of the 2,000 million inhabitants of our globe is equalled by the power emitted by five working thunderclouds.

So, if on a night in which atmospherics tend to drown the wireless programme any reader should feel resentment mounting within him, I would recommend him to read again this article and ponder over the remarkable events and gigantic forces of which he has the privilege to be an auditor. *Tout comprendre, c'est tout pardonner.*

Further articles in this series will deal with the following subjects:—

2. The Stratosphere, the world of fair weather and intense sunshine.
3. The Ozone Layer, and its protective action.
4. The Ionosphere, the home of the Heaviside and Appleton Layers.
5. Absorption of wireless waves, and wireless echoes.

The Tone-control Transformer

Principles of Operation and Design

By L. E. C. HUGHES, Ph.D.

ALTHOUGH tone-correcting LF transformers, of which the frequency characteristics may be adjusted through an external control to suit varying needs, have been in use for some time, little technical information has hitherto been published on their design.

MANY readers of this journal are well acquainted with methods of tone correction and control as applied to radio reception. Tone control is, briefly, the art of adjusting frequency-response curves of apparatus to specified shapes. This can be done with exactness when all the apparatus and suitable measuring gear are available. In broadcasting, it is not possible to get at both ends of the system at the same time and measure the overall response; indeed, there is some difficulty in deciding the definition of such a response, including, as it does, the acoustic conditions of and surrounding the microphone and loud speaker.

Supposing that the response curves under the control of the broadcasting authorities are adjusted to an acceptable shape up to the radiation, there remain variabilities in the receiver, such as in the selective circuits and in the position of the reproducer, which make empirical tone-control an asset, so that the optimum overall response can be attained in a variety of conditions.

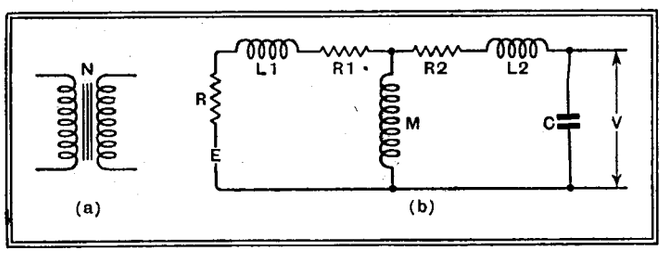


Fig. 1.—A normal LF transformer and its equivalent circuit.

The tone-control transformer is a device providing for continuous adjustment of frequency response, and no doubt many of its users desire to know its principle of operation.

Normal Transformer Action

Its circuit is based on an ingenious combination of properties of transformers. The tone-control transformer is more simply explained, therefore, from a consideration of the equivalent circuit of the conventional double-wound transformer.

Referring to Figure 1, a transformer with turns ratio N in (a) is equivalent to the network (b) in series with an ideal transformer of turns ratio N, that is, one with infinitely great primary and secondary impedances and no leakage inductances.

M is the mutual inductance of the transformer when the ratio is reduced to 1/1, instead of N, by dividing all the secondary impedances by N^2. The primary and secondary leakages and effective resistances are represented by L1, L2, R1 and R2 respectively. C is the self-capacity of the secondary winding, depending only on the shape of the winding and which end of the windings or the core is earthed, and independent of the actual number of turns. The larger is N in an actual transformer of fixed size secondary, the greater is C in the equivalent circuit, since it becomes multiplied by N^2.

The terminations of a transformer are most important. The primary is connected to a source of electro-motive force, E, in series with an internal impedance R, generally resistive, as in a thermionic valve. In the latter, E is the product of the applied voltage to the grid and the amplification factor.

The response of the transformer is defined as the ratio of the secondary voltage V, since this is applied to the grid and determines the power output of the succeeding valve, to E, *not* to the voltage applied to the primary of the transformer. The response is plotted for each frequency as

$$20 \log_{10}(V/E) \quad .. \quad .. \quad \text{decibels},$$

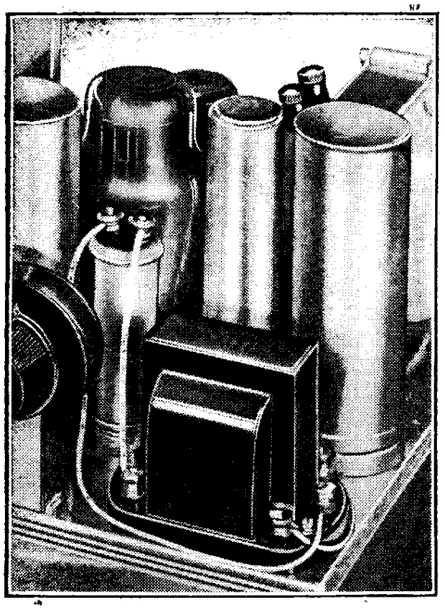
in conformity with all other response curves which determine ultimately the overall response curve of an acoustic system. To this is added

$$20 \log_{10} N \quad .. \quad .. \quad \text{decibels},$$

indicating the gain obtained by virtue of the fact that the device transforms.

In practice, the network of Figure 1 (b) is not on open circuit, but operates into a grid-capacity, which is determined by the constants of the valve and the load in its anode circuit. The circuit is simplified by adding this grid input-capacity in parallel with the self-capacity of the secondary of the transformer.

At medium frequencies the impedance of M and C are high and do not appreciably shunt the transmission line. Also the leakage impedances are small in comparison with M, the leakage impedances being normally less than 1 per cent. of M. Hence V=E; there is no gain or loss, apart from the step-up, centre of curve A, Fig. 2.



The tone-control transformer in practical use. A Multitone component incorporated in *The Wireless World* Universal AC-DC III.

At low frequencies M becomes an appreciable shunt, due to its fall in impedance; there is a voltage drop in R, V is less than E, and there is a progressive loss in the bass.

With increasing frequency the series-leakage impedance rises and thus provides an increasing drop for the greater current taken by C. At some frequency, when the reactance of C equals the leakage reactances, the current through C may be a maximum; hence the response may be a maximum. At very high frequencies C becomes a short-circuit and the response tends to zero. The magnitude of the resonant current, for a given E, depends on the series effective resistance, that is, the losses in the transformer windings, both copper and iron, and the impedance of the source R. If the latter is low, the resonant current may result in V being

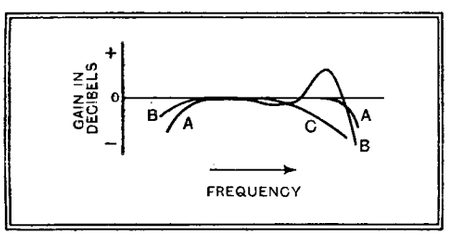


Fig. 2.—Response curves of normal transformers.

The Tone-control Transformer—

considerably greater than E, as in curve B. At the same time, the response is held up in the bass because at a given frequency M takes a larger voltage drop. If the source impedance R is high, then the resonant current is small and V may be less than E, as in curve C. If the grid is shunted by a resistance, such a load reduces the top response also.

The art of designing a transformer with a level response over a wide frequency range is, therefore, the adjustment of the mutual M, the leakages, and the self-capacity C, so that the resonant current at the upper end of the response curve has the right value to make the ratio V/E the same as at a medium frequency.

High-permeability Cores.

Now M depends on the number of turns placed on a given sized core, and the percentage leakage inductances on the permeability of that core. The use of nickel-iron alloys of high differential permeability results in a smaller core for a given M; the smaller core also results in a smaller C, since this diminishes with the dimensions of the winding. Thus improved core material helps in two ways in obtaining a level response over a wide range for a given step-up, because increases of the leakage inductance or effective self-capacity of the secondary winding both reduce the secondary resonant frequency.

In a given transformer, information for further design is easily obtained. M is substantially the primary inductance and is measured at low frequency, say 50 c/s, on a bridge with a vibration galvano-

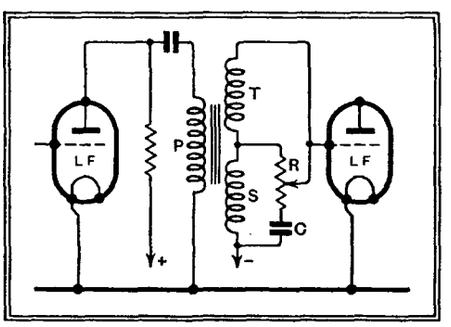


Fig. 3.—Connections of a tone-control transformer.

meter, or simply with a thermocouple or rectifying instrument to measure series current and a valve voltmeter to measure voltage drop. The leakages, which cannot be distinguished practically, are measured by taking the primary impedance with the secondary shorted.

The self-capacity of the secondary is found from the leakage reactances by ascertaining at what high frequency the primary impedance is a minimum and resistive; the value of this resistance is clearly the series effective resistances. As a check, M and C resonate and the primary impedance becomes a maximum and resistive at some middle frequency, which is readily obtained with a suitable bridge.

There are subsidiary effects due to capacities between the windings which modify the response curve slightly in practice, but they do not modify the preceding argument.

Turning now to the tone-control transformer, Fig. 3, it consists of a normal primary P, suited to the source impedance, a main secondary S, and a further secondary T connected by an external high-resistance potentiometer R and a con-

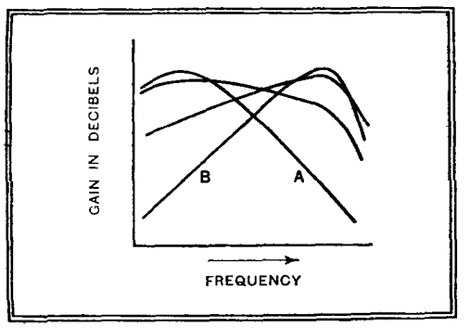


Fig. 4.—Various types of response curve obtainable from a tone-correcting transformer.

denser C, which is conveniently formed from a bifilar winding on the primary.

Remembering the action of a normal transformer, the modified transformer acts as follows. With the slider at its lower extremity S and T resonate with C. The latter is adjusted so that the resonant frequency is about 90 c/s, above which the response, as measured by the ratio of the voltage applied to the second grid to the voltage applied to the first grid, falls off rapidly, as indicated in Fig. 4, curve A.

With the slider of R at the upper end, T is shorted on the core and the comparatively heavy short-circuit ampere-turns are balanced by primary ampere-turns, with the result that the apparent primary impedance falls to a low value. Remembering that the valve has a fixed differential anode resistance, loss in primary impedance means that there is a larger voltage drop in the valve, less voltage is applied to the primary, less voltage transformed by S, and so the response is low.

The short-circuit current is a maximum at the lowest frequencies. As the frequency rises, so does the reactance of the leakage of T, with consequent drop in short-circuit current, rise in primary impedance, increase of voltage applied to primary, and increase in overall response, as indicated by curve B.

The response continues to rise until the resonant frequency of the winding S is passed, after which the response drops sharply, as is normal.

For intermediate positions of the slider of R, there is a combination of the resonant current in S and the short-circuit current in T, and response curves intermediate between A and B are obtained, the change from one response curve to another being continuous with rotation of the potentiometer R.

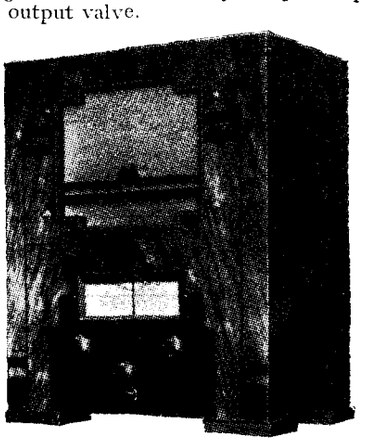
The range of frequency response is determined by the step-up ratio as previously explained. It is not possible to have both high gain due to step-up and great band-width of response. Moreover, to get the range of control in response it is necessary to adjust the leakage of T, which means, in practice, the permeability of the core material, within close limits.

The tone-control transformer gives, therefore, a considerable margin of response tilt in both directions, a property which has been found of considerable use not only in radio-receivers, where it is most used, but also in deaf-aids, for which it was devised, and in public-address systems; in fact, in all reproducing systems which have to work in adverse acoustic conditions and which require adjustment of their overall response.

Marconiphone Model 223

THE latest addition to the "Jubilee" series of Marconiphone receivers is an AC/DC superheterodyne which has been introduced to meet the demands of those who anticipate a change in the nature of their supply mains.

An unusually interesting three-valve circuit has been adopted in which the middle valve, a double-diode-pentode, performs the functions of IF amplifier, second detector, AVC, and LF amplifier. This versatile valve is preceded by a heptode frequency-changer, and is followed by a separate pentode output valve.



Marconiphone Model 223 AC/DC Superheterodyne

Special attention has been given to the question of heat dissipation, which is of necessity a very real problem in table sets employing universal valves, and deflecting cowls have been included to maintain steady convection currents.

The price of the Model 223 is 11½ guineas.

Jubilee Issues

THE principal motoring happenings during the King's reign are described in a beautifully produced Jubilee issue of our sister journal, *The Autocar*, dated May 3rd, which also includes an authoritative description of His Majesty's garage and cars at Buckingham Palace.

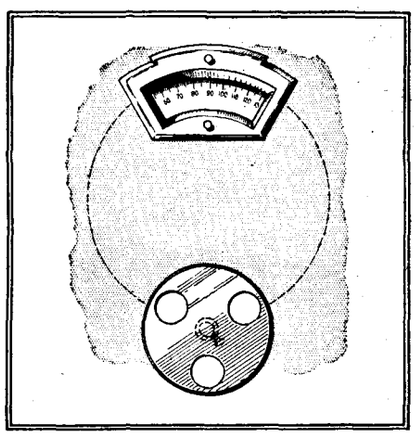
An article on "Snapshotting Royalty" appears in the special Jubilee issue of *The Amateur Photographer* (May 1st), together with details of a Jubilee competition. *The Yachting World* (May 3rd) gives a vivid record of the King's activities on the famous Royal cutter, *Britannia*.

HINTS AND TIPS

Practical Aids to Better Reception

A CRITICISM sometimes directed against all-wave receivers is that the ratio of the tuning drive fitted is too low for the very fine adjustments needed on short waves. Actually, this is not due to short-sighted manufacturing policy, but to the fact that a reduction gear really high enough for the short waves would make tedious an exploration of the medium and long waves. Another possible disadvantage of a high ratio is that it can give a quite false impression of poor selectivity, particularly on long

A Dual-Purpose Tuning Knob



On the principle of the dial telephone ; an easily made two-speed drive.

waves. Consequently, failing a suitable two-ratio drive, the ultimate choice is a compromise between the two requirements, with a bias in favour of the higher wavelengths, which are likely to be the most used by the average listener.

Conversely, with sets designed primarily for short waves, the slow-motion ratio is sometimes so high that the user is irritated by the tedious operation of repeatedly turning the knob ; a strong desire is felt for some way of speeding up the tuning process when skipping from one waveband to another.

Those who use this type of set may be interested in a simple device which permits both fast and slow control to be obtained with a standard tuning drive. It is suggested that the usual tuning knob should be replaced by a large flat disc—a convenient form being the type used for vernier thumb-controlled condensers; near the periphery a hole (or several symmetrical holes) is drilled, suitably countersunk so that it fits the tip of a forefinger comfortably.

Now, by placing a finger-tip in the hole and rotating it from the knuckle joint, thereby spinning the "dial" as when using an automatic telephone, one can pass from one end of the scale to the other in far less time than by the usual "twiddling" method ; while for the relatively slow and careful process of tuning in a station, the large size and knurled rim of the disc enables one to make the finest adjustments with the greatest accuracy.

WITH the object of obtaining the maximum amount of undistorted volume from an output valve, every effort should be made to apply to its anode the highest possible voltage up to the limit imposed by the manufacturer.

HT Voltage and Power Output

The reason for this advice is that the decline in AC output is not merely proportional to reductions in HT voltage ; it is much worse than that, amounting in practice to the square of the voltage.

As an example, by halving the anode voltage, the power output is reduced, not by half, but to a fourth of the figure corresponding to maximum rated voltage.

WHEN fluctuations in signal strength and changes in quality of reproduction take place during the hours of daylight (true fading should not then occur on the normal broadcast bands) we have a fairly certain indication, if the receiver is a superheterodyne, that the oscillator frequency is "wandering." It may be, of course, that the source of the trouble is external, but this is hardly likely nowadays.

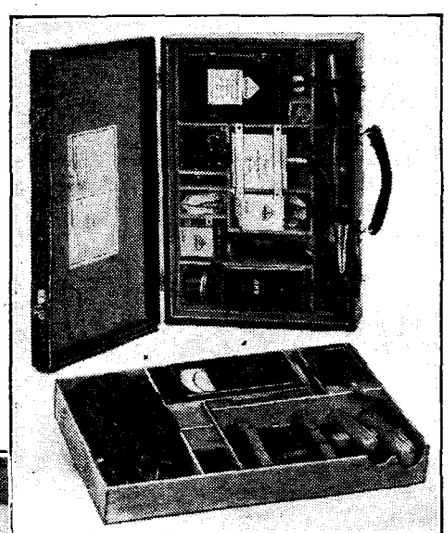
Inconstant Oscillator Frequency

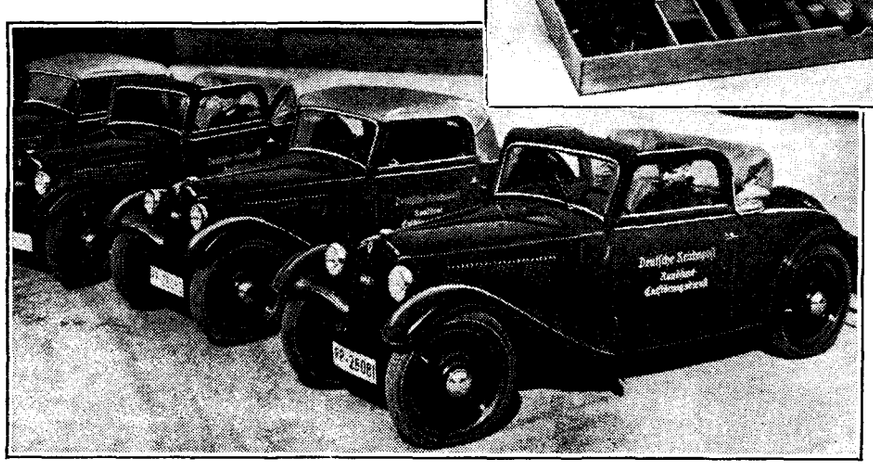
In any case, the point can be determined quite easily with the help of an extemporised oscillator consisting of the reacting detector circuit of a borrowed receiver. The procedure is to tune the suspected receiver to a signal which is subject to variation, and then to heterodyne it from the local oscillator, when a whistle of pitch dependent upon the setting of the oscillator condenser will occur. If the pitch of this whistle is observed to vary when the volume varies, it may be concluded, with some confidence, that the trouble is due wholly to wandering of the oscillator frequency.

IN a recent issue it was pointed out that the small mass-plate type of accumulator is hardly suitable for the filament-current demands of five- or six-valve sets. The truth of this assertion can often be proved by checking the voltage of one such overworked cell after a prolonged period of listening, and it is a fact that many cases of poor performance and erratic behaviour can be traced to inadequate low-tension supply, particularly amongst last season's superheterodynes, which, generally speaking, contain a minimum of five valves.

Accumulators for Superhets

For example, in a set of this type it sometimes happens that the detector-oscillator valve suddenly stops oscillating, or fails to oscillate over the whole wave-range. This is most likely to occur with screened-grid "cathode-injection" frequency changers, where the oscillator coupling coil is inserted in the filament leads ; with this arrangement there may be insufficient reaction coupling to maintain oscillation when emission falls through even a slight decline in filament voltage.





GERMANY WAGES WAR ON INTERFERENCE.—A fleet of 65 cars are being put into service for tracing and suppressing electrical disturbances. Above is shown the portable kit of tools and instruments with which each of the investigating engineers is provided.

Current Topics

Events of the Week in Brief Review

Keeping It Dark

THERE is to be no public radio show in America during 1935. Such is the decision of the U.S. Radio Manufacturers' Association, which meets in Chicago on June 11th and 12th for a secret session on set designs for 1935-6.

Medium Waves Span Atlantic

TESTS conducted by the new Rennes-Bretagne Regional station, working on 288.5 metres between 4 and 6 a.m., have revealed that this 120-kilowatt medium-wave transmitter is easily heard in America.

Sir Ambrose Fleming

SIR AMBROSE FLEMING, inventor of the thermionic valve, has been awarded the Franklin Medal for 1935 by the Franklin Institute, Philadelphia, for his work in the field of wireless research. The name of Sir Ambrose is coupled with that of Professor Einstein, who receives a similar medal for his researches into relativity.

The Listener's Chance

BELIEVING that the only bar to the complete enjoyment of broadcast programmes is the listener's inability to reply, the Stuttgart station authorities are introducing a Listeners' Programme once a fortnight. During these two-hour sessions, representative listeners are led to the microphone and permitted to catechise the station director on matters pertaining to the arrangement of programmes.

French Television Claim

NONE other than M. Mandel, the French P.M.G., is responsible for the statement that the Eiffel Tower will soon be transmitting television "better and more up to date than anything in Great Britain or Germany."

A smaller edition of the apparatus, which is all-French, is about to begin broadcasts from Paris P.T.T. parallel with the ordinary sound broadcasts. These will be on 175 metres, with 60-line scanning at 25 frames per second.

The Eiffel Tower tests three months hence will employ 240-line scanning.

Paying the Postman

RADIO licence fees in Italy have hitherto been collected by postmen, but there are certain objections to this arrangement, including possible non-delivery of letters to delinquents. In future Italian listeners must pay at the post office.

"Free Shows" Battle in U.S.

AMERICAN theatrical producers and actors' organisations are complaining against the prevalence of "free shows" provided by the broadcasting networks. It is estimated that about 5,000 persons attend weekly in the studios of the two main networks, while large numbers occupy complimentary seats at the minor broadcasting stations.

The largest attendances are in the large and small studio theatres at Radio City, New York.

The broadcasters' contention is that radio artists demand a visible audience as a stimulus to better performance, but it seems doubtful whether theatre organisations appreciate the strength of this argument. Probably they would prefer that the standard of broadcast performance was not too high.

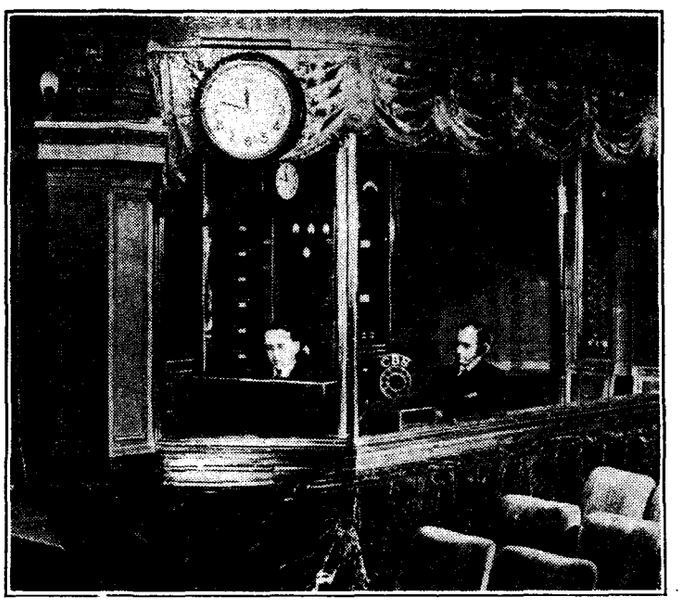
Listening in France

FRENCH registered listeners numbered 1,882,607 at the beginning of March, 843,789 belonging to the Paris district.

Mexico Tells the Universe

STATION XECR has been opened by the Mexican Ministry of Foreign Affairs "to carry out active propaganda of news on behalf of Mexico's good name abroad." In an official notice we read that "XECR will serve lofty aims, as in addition to broadcasting all over the universe the truth in regard to the situation in Mexico, it will do its share towards drawing closer the bonds of international friendship and rectifying by actual facts distorted world opinions in regard to the Republic of Mexico, originated by malevolent and misleading reports."

XECR works on 40.6 metres (3,780 k/c) every Sunday from 23.00 to 24.00 G.M.T.



A CATHODE RAY OSCILLOGRAPH is used by the engineers as a visual check on quality in this control cabinet in the Columbia Broadcasting system's Radio Playhouse near Times Square, New York. Non-paying audiences of 750 persons can attend the performances, and the theatrical profession is complaining bitterly.

Wonders of the Detector Van

AN amusing tale is told in the *Post Office Magazine* of a visit of the P.O. "detector" van to the elderly landlord of a Welsh inn. When the licensee explained to the engineers that his son had taken the wireless licence out with him, he was informed that he would find it in the pocket of his son's blue coat. Sure enough the licence was there, and the old man's astonishment was wonderful to behold when, asking how the engineers knew, he was informed, "This is the licence detector van you've been reading about."

Not till evening did he learn that his son had met the van on the road prior to its visit and had told the Post Office men where the licence was to be found.

Alternative Programmes

THE first serious attempt to introduce alternative broadcast programmes in France, with a contrasting appeal, will be made at the end of this month. When Radio-Paris is broadcasting dramatic and literary material, the Eiffel Tower will offer light music, and vice versa. The principle will ultimately be extended to include the whole of the French Regional scheme.

"Ultra-Shorts" in Central London

DIRECTIONAL and omni-directional 5-metre transmissions will be carried out on Sunday, May 19th, by the International Short Wave Club on the roof of *The Daily Telegraph* building in Fleet Street, London, and a special appeal is made for listeners to report on the tests. It is hoped to secure reports from listeners located over 200 miles away.

A complete schedule of the tests, which will run from 11 a.m. to 4.30 p.m., will be published in next week's *Wireless World*. The "Ultra Short Wave Two," which was described in the issue of this journal dated June 16th, 1933, is a very suitable receiver for those who wish to take part, being of simple construction and capable of reception up to two or three hundred miles. A limited number of copies of the issue can still be obtained from the Publisher, Dorset House, Stamford Street, S.E.1.

N.R.E.A.

THE suggestion that a printed list should be prepared showing the usual charges for ordinary radio repair jobs is being considered by the National Radio Engineers' Association.

Since the recent formation of the Association successful meetings have been held in Leicester, Nottingham, Plymouth, Bristol, Cardiff and Newcastle. Organisers have been appointed for Norwich, Manchester and Barnsley.

Radio engineers are invited to apply for full particulars of the Association's activities to the Secretary at 48, High Road, London, N.2.

Components Famine

RESTRICTION of imports has placed Roumania in the sorry position of not having enough radio parts, writes a correspondent. As a result the radio factories are working only three days a week, while amateur construction work is at a standstill.

The Royal Week—*Listeners'*

THE JUBILEE AND THE LISTENER

IN all national events broadcasting now elbows its way to the front, and the freedom of the microphone vies with the freedom of the Press. Almost it might be said that the "mike" rushes in where angels fear to tread; certainly there will be no important feature of next week's Jubilee celebrations in which listeners will not be able to have some share.

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YORK MINSTER

THE first item in the Jubilee Week broadcasts is the Military Service from York Minster at 10 o'clock on Sunday morning next, in which the bands of the 16/5th Lancers, the 2nd Battalion the Northumberland Fusiliers, and the 2nd Battalion Manchester Regiment will take part. The Archbishop of York will preach the sermon.

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"HENRY V"

IT would be difficult to choose a more fitting play than "King Henry V" for the Shakespearean broadcast on Sunday afternoon at 5.30. Howard Rose is the producer of a studio version in which Leslie Banks takes the part of Henry V, A. Scott-Gatty that of Charles VI of France, and Celia Johnson that of Katherine, Henry V's Queen.

There are some "purple patches" in "Henry V" which will always bring a thrill to Englishmen, especially at times of national rejoicing.

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INTER-DENOMINATIONAL SERVICE

A UNIQUE religious service will be held in the Concert Hall of Broadcasting House at 7.55 on Sunday, the officiating clergy being the Archbishop of Canterbury; the Rev. S. M. Berry, D.D., Moderator of the National Council of Evangelical Free Churches; and the Rev. Marshall Lang, Moderator Designate of the Church of Scotland.

Part of the London Symphony Orchestra will accompany the B.B.C. Chorus under the direction of Adrian Boult, with Thalben Ball at the organ. During the service there will be sung "Oh Lord Save the King," an anthem composed specially for the occasion by Sir Walford Davies, Master of The King's Musick.

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TWENTY-FIVE YEARS OF BRITISH MUSIC

ROUNDING off the programmes on the eve of Accession Day will be a concert by the B.B.C. Orchestra (Section B), under Sir Henry Wood, of works by British composers as first performed at Promenade Concerts since 1910 (Reg. 9.20). The composers include Walton, Delius and Bax.

THE JUBILEE BROADCASTS

MONDAY, MAY 6th.
(ACCESSION DAY.)

11.5 a.m., Commentary on the Procession to St. Paul's.
11.30 a.m.—12.30 p.m., Service relayed from the Cathedral.
6.30 p.m., "Twenty-Five Years"—Special Empire Jubilee Programme.
8.0 p.m., The King's Speech.
10.15 p.m., The Poet Laureate.

THURSDAY, MAY 9th.

11.20–11.50 a.m., Lords and Commons present Loyal Address to the King; relayed from Westminster Hall.
(All B.B.C. Stations.)

Portraits by Hoppé

NATION AND EMPIRE will tune in to St. Paul's at 11.30 a.m. on Monday next for the "Thanksgiving Service for the protection afforded to the King's Majesty during the Twenty-five Years of his Auspicious Reign." The King and Queen will drive in state to the Cathedral.

HIS MAJESTY'S JUBILEE

ACCESSION DAY, May 6th, will be notable for the fact that, thanks to broadcasting, more subjects of His Majesty will be participating in a great national thanksgiving than ever before.

The relay of the "Thanksgiving Service for the Protection afforded to the King's Majesty during the Twenty-five years of his Auspicious Reign, ordered by the Lords of His Majesty's Most Honourable Privy Council in the Cathedral Church of St. Paul, London," will be preceded by a broadcast description of the arrival of Their Majesties The King and Queen at Temple Bar, and of the scene outside the Cathedral. Later will come a commentary on the Royal departure from the Cathedral, given by Commander Stephen King-Hall, R.N.

Approximately at 11.5 a.m. the Jubilee broadcast will open with joy bells. Next, a commentator at Temple Bar will describe the arrival of the Prince of Wales; crowd noises will be heard, and then will follow a word picture of the arrival of Their Majesties at the City Boundary. As the procession moves on the narrative will be taken up by a commentator outside St. Paul's Cathedral which should be reached at about 11.24.

Slowly the cheers of the crowd will fade into the strains of the St. Paul's organ, and at 11.30 the service of thanksgiving will begin.

The proceedings will be broadcast by all stations of the B.B.C., including the Empire transmitters at Daventry.

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RADIO DRAMATIC SURVEY

"TWENTY-FIVE Years" is the appropriate title for the programme at 6.30 compiled by Dr. Harold Temperly and produced by Laurence Gilliam. This radio dramatic survey of the King's reign will deal in sequence with: Accession; Early Travels; Coronation; Delhi-Durbar; Pre-war World; the Great War; the New Age; the New Empire; the King and His Ministers; the King and His People.

An important feature of the programme will be the reconstruction of the King's Coronation Service at Westminster Abbey in 1910. For this purpose the actual music used in the service has been recorded by the Abbey Choir and the organ, under the direction of Dr. Bulloch.

At 7.40 p.m. comes the "Empire's Tribute." This will take the form of loyal messages of greeting to His Majesty from all British possessions, including a direct relay from the Viceroy of India. There will be relays from

Guide to the Jubilee Broadcasts

By The Auditor

Southern Rhodesia, South Africa, Australia, New Zealand, Canada, and a speech by His Excellency the Governor of Bermuda. The message from Newfoundland will be a recorded one, relayed from Ottawa. Finally, the Prime Minister, The Rt. Hon. Ramsay MacDonald, will deliver an address to His Majesty on behalf of the United Kingdom.

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THE KING'S MESSAGE

AT 8 p.m. H.M. The King will deliver his message to the Empire from a small room overlooking the gardens of Buckingham Palace. The technical arrangements will be the same as those for the Sandringham broadcast at Christmas. His Majesty will speak alone from a room adjoining that in which the technical controls are placed. All equipment will be in duplicate, and the lines connecting the Buckingham Palace switchboard with Broadcasting House will be specially chartered private circuits.

An interesting "postscript" to the Jubilee programme will occur at 9.45 when spokesmen in towns in all parts of the British Isles will contribute to the News Bulletin their own impressions of the events of Jubilee Day.

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FUN IN BRIGHTON

AFTER the happy but somewhat restrained Jubilee programme we shall hear (8.10) mighty fun going forward in the Brighton Corn Exchange, where the Jubilee Civic Celebrations will be in full swing. In a special top-notch variety bill we shall hear the Dancing Daughters, Norman Long, Jane Carr, Elsie and Doris Waters, Nosmo King and Partner, Anona Winn, Leonard Henry, and Jack Payne and His Band.

Dance music will be relayed from Brighton from 11.30 p.m. to 1 a.m.

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TWO FAMOUS POETS

FROM the Corn Exchange listeners will be switched through an hour later to the Connaught Rooms, where the "Poet of Empire," Rudyard Kipling, LL.D., D.Litt., will be heard in a speech at the annual Banquet of the Royal Society of St. George. And then, at 10.15 p.m., we shall hear the Poet Laureate, Mr. John Masefield, deliver his new Jubilee poem.

A great day, in which the programmes will be of such a standard that no alternatives will be called for.

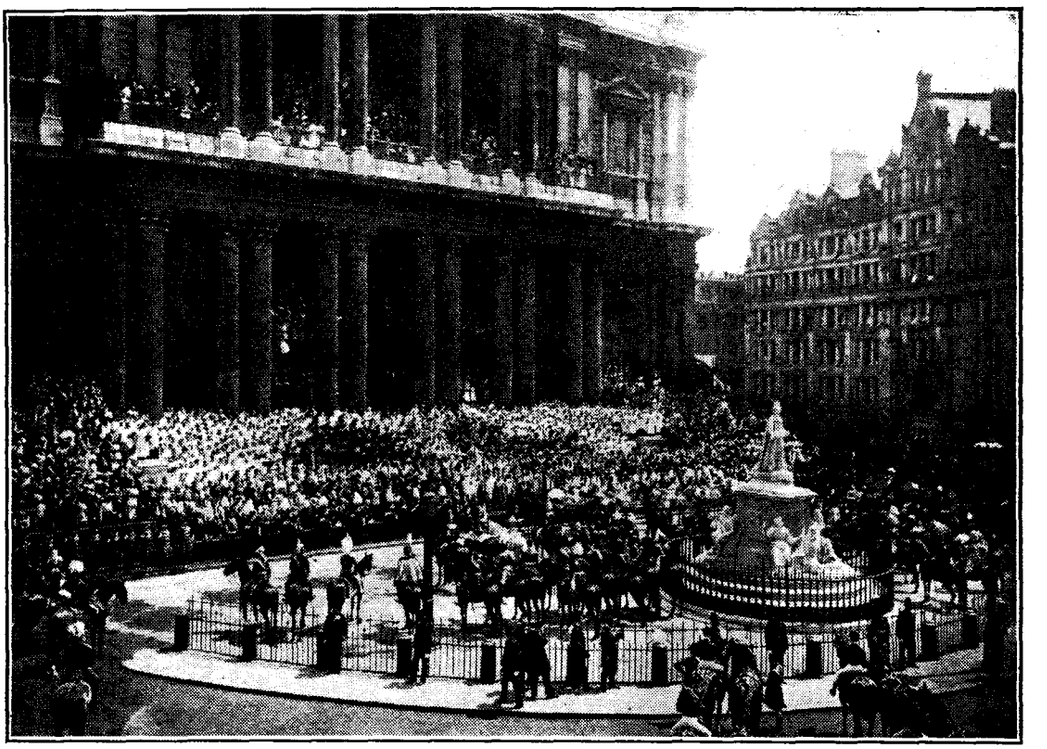
REVELATIONS IN "FAMOUS TRIAL"

JUBILEE week will see the broadcasting of a "Famous Trial" which first gave to British juries the unassailable authority which they enjoy to-day. This is the trial of William Penn, which took place in the year 1617, and will be heard by listeners in the National programme on Tuesday next, May 7th, at 8 p.m., and in the Regional programme at 8.45 on May 8th.

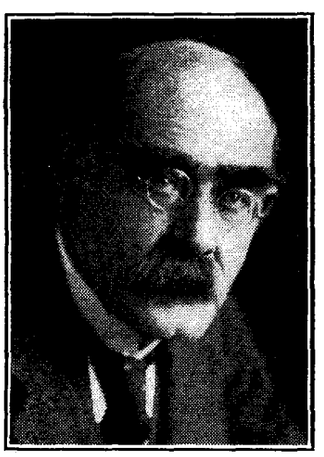
Ten years before he founded the State of Pennsylvania William Penn, a Quaker, was arrested in England for unlawful assembly while speaking at a meeting. Leslie Baily's broadcast version of the trial which followed will reveal that this was the occasion which gave British juries the right to return a verdict according to their own opinion. In the Penn trial the judges tried to insist on a verdict of their own, and used extraordinary methods to force the jury to alter their opinion, without avail.

COVENT GARDEN

NEVER before has an opera at Covent Garden been relayed in its entirety. At 8.10 on Tuesday next, May 7th, the whole of "La Cenerentola" (Cinderella) will be heard, the cast including Conchita Supervia, and Pierisa Giri.



THIRTY-EIGHT YEARS AGO St. Paul's Cathedral saw another Royal Thanksgiving Service on the occasion of the Diamond Jubilee of Queen Victoria in 1897. This interesting photograph shows the service in progress, the aged Queen remaining seated in the royal carriage.



RUDYARD KIPLING, LL.D., D.Litt., the "Poet of Empire," whose speech at the Banquet of the Royal Society of St. George will be heard on the evening of Accession Day.

"THE DESERT SONG"

A comedy which has never ceased running since its original production at Drury Lane comes to the microphone in Jubilee week. This is "The Desert Song," with Edith Day and Harry Welchman. The popularity of "The Desert Song" is amazing, and it has established itself as a firm favourite in all the provincial theatres, rivalling even Gilbert and Sullivan.

Henrik Ege's radio version will play for about 1¼ hour, and will be given at 7.30 (National) on Wednesday, May 8th, and 8.45 (Regional) on May 9th. The book and lyrics are by Otto Harbach and Oscar Hammerstein. All the popular music has been left in, and the Wireless Chorus and

The Royal Week—

the Dancing Daughters will be heard. John Watt is the producer, and the Theatre Orchestra will be under the direction of Stanford Robinson.

"THE DESERT SONG." Edith Day and soldiery in the original Drury Lane production. This vivacious musical comedy, which has never ceased to run at one provincial theatre or another since its start, will be broadcast with Edith Day and Harry Welchman at 7.30 on Wednesday (Nat.) and 8.45 on Thursday (Reg.).

LORDS AND COMMONS

ONLY less important in Jubilee week than the happenings of Accession Day will be the presentation of addresses to His Majesty by the Lords and Commons at 11.20 a.m. on Thursday next, May 9th, in Westminster Hall.

The address on behalf of the House of Lords will be given by the Lord Chancellor, the Rt. Hon. Viscount Sankey, G.B.E., and on behalf of the House of Commons by the Rt. Hon. E. A. FitzRoy, the Speaker. These and the speech by His Majesty will be broadcast, as well as a running commentary by Commander Stephen King-Hall.

VARIETY OF EMPIRE

EMPIRE stars will join hands at 8 p.m. in "Empire Variety" in the National programme on Thursday, May 9th. The artists will include Al and Bob Harvey (Canada); Afrique (South African Impersonator); Albert Whelan (Australian Entertainer); Anona Winn (Australia); and many others. The accompaniments will be played by that popular member of the B.B.C. Staff, Miss Jean Melville, who is Australian born.

A special overture to "Empire Variety" has been written by Frank Tapp, who won the second prize in the *Daily Telegraph* Concert Overture Competition with his overture "Metropolis." This received its first performance at a Queen's Hall Promenade Concert last August.

A RUSSIAN RESTAURANT

MUCH has been said about the Light Entertainment Department's new feature, "The Red Sarafan," an entirely new Russian orchestra under the direction of Emilio Columbo, formerly Court violinist to the late Czar of Russia. At 8.45 p.m. on Tuesday next, May 7th, "The Red Sarafan" will be put to the test of a National transmission.

"The Red Sarafan" will be directed by the Marquis Vivien de Chateaubrun, who holds the British Military Cross as well as numerous Russian decorations. Olga Alexeeva and Capt. Sorokin's Siberian Cossacks will be heard in a programme of traditional Russian peasant music and songs. The atmosphere will be reminiscent of a fashionable restaurant in the St. Petersburg of pre-war days. In order not to make the feature entirely strange it is proposed until listeners become acclimatised to include a number of familiar tunes.

HIGHLIGHTS OF THE WEEK

FRIDAY, MAY 3rd.

Nat., Smetana's "Ma Vlast," Part I.—B.B.C. Orchestra (D).
Reg., Vienna Philharmonic Orchestra, relayed from Birmingham.
Abroad.
Leipzig, 10.30, The Leipzig Symphony Orchestra.

SATURDAY, MAY 4th.

Nat., "Dancing Through"—pageant of popular music during the past 25 years: Geraldo and his Orchestra.
Reg., Smetana's "Ma Vlast," Part II—B.B.C. Orchestra (D). ¶ Speech by H.R.H. Duke of York at Royal Academy Banquet.
Abroad.
Brussels II, 6, Beethoven Concert.

SUNDAY, MAY 5th

Nat., 10 a.m., Military Service in York Minster. 5.30 p.m., "Henry V" (Shakespeare). 7.55 p.m., Special Service in Broadcasting House.
Reg., 6.45, Music of the British Isles. B.B.C. Orchestra (E).
Abroad.
Radio Paris, 9, Concert on Anniversary of Death of Napoleon.

MONDAY, MAY 6th.

Nat. and Reg., For Jubilee broadcasts see previous page. 8.10 p.m., All-Star Variety from New Corn Exchange, Brighton. 11.30 p.m.–1 a.m., Dance Music from Brighton.
Abroad.
Warsaw, 9, Handel and Bach Concert.

TUESDAY, MAY 7th.

Nat., 8, "The Trial of William Penn." 8.45, "The Red Sarafan."
Reg., 8.10, "La Cenerentola" (Rossini) from Covent Garden.
Abroad.
Bordeaux-Lafayette, 8.30, Music by Bordeaux Composers.

WEDNESDAY, MAY 8th.

Nat., 7.30, "The Desert Song."
Reg., 8.45, "The Trial of William Penn."
Abroad.
Kalundborg, 8, Scandinavian folk music.

THURSDAY, MAY 9th.

Nat., 8, "Variety of Empire." 10, "Siegfried" (Wagner) Act III, from Covent Garden.
Reg., 8.45, "The Desert Song."

PROGRAMMES FROM ABROAD

FRIENDS OVERSEAS

FOREIGN interest in the Silver Jubilee of King George is reflected in the broadcasting arrangements. American listeners are promised "highlights of the King's Jubilee celebrations" over both the National and Columbia networks, beginning with a relay of the religious service in Broadcasting House on Sunday evening and including the Thanksgiving service in St. Paul's on Monday and the Westminster Hall speeches on Thursday.

The Dutch short wave station PHOHI (Philips Omroep Holland Indie), which is heard in British India, America and the Straits, will relay a 25-minute talk on Sunday on "The Silver Jubilee of H.M. King George V of England," operating on wave lengths of 16.75 and 19.71 metres.

The talk will be repeated by Hilversum (N.R.C.V.) on May 6th. The speaker will be Mr. K. D. Koninly, editor of the daily newspaper *Algemeen Handelsblad*, and will be concluded with the playing of "God Save the King."

DANISH COMMENTATOR IN LONDON

DENMARK is sending to London one of her best radio commentators, Mr. Svend Carstensen, editor of the Danish broadcast news bulletins. Mr. Carstensen will broadcast a word picture of the Jubilee celebrations, his description being cabled to Copenhagen and relayed by wireless.

The Danish network will also relay practically the whole of the B.B.C. programme on the evening of May 6th, including the King's speech and the address presented by Mr.

Ramsay MacDonald, followed by the Variety programme from the Corn Exchange, Brighton.

HANS ANDERSEN

THE memory of Hans Christian Andersen, spinner of fairy tales, is always cherished in Northern Europe, and there will be a number of programmes commemorating the Andersen centenary during the coming week.

One of the most novel will be broadcast from Copenhagen-Kalundborg at 10.10 p.m. on Tuesday next, May 7th, consisting of a concert of music by Danish composers embodying "H. C. Andersen motifs." The famous fairy tales have been translated into almost as many languages as the Bible.

DENMARK AND THE JUBILEE. Harald Rud, of the Danish State broadcasting organisation, who will interpret the Jubilee speeches as they are relayed to Copenhagen from London.

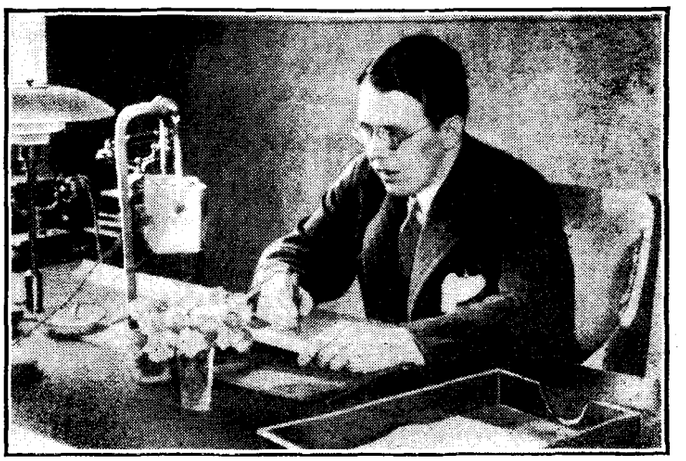
FOLK MUSIC BY LIVING COMPOSER

A 75-YEAR-OLD composer, Von Reznicek, will himself conduct his commemorative birthday concert, to be broadcast from all German stations this evening (Friday) at 8.15. Von Reznicek is one of the few living composers with folk songs to their credit, and three of these, taken from "Des Knaben Wunderhorn," will be sung this evening by the tenor, Heinz Marten.

Vienna also pays homage to the composer this evening in a broadcast at 8 p.m. of his opera "Donna Diana."

IS IT CHANCE ?

COINCIDENCE plays some strange tricks with the European broadcast programmes.



VISITOR FROM ABROAD. Svend Carstensen, editor of the Danish broadcast news bulletins, who will give a running commentary on the Jubilee celebrations for the benefit of listeners in Denmark.

Often one waits for months to hear a particular item and then, for no apparent reason, the very item in demand appears in one programme after another. Can it be that the station directors work on a rota system and that, by the machinations of Fate, certain pieces are bound to coincide year after year?

Of late I have missed Schubert's "Unfinished Symphony" in the programme lists, but to-night it appears in the programmes of Brussels and Budapest. Brussels No. II gives a special Schubert concert, with the Symphony Orchestra conducted by Meulemans, at 8 p.m., and the "Unfinished" is included. The Budapest version will be heard at 10.20.

NAPOLEON

LISTENERS with a working knowledge of French will be interested in two literary programmes to be given by Paris stations. To-night (Friday) from 8.30 to 10.30 Paris P.T.T. and Eiffel Tower will broadcast a dramatic production based on the works of Gerard de Nerval (1808-1855), a man of letters who was also a distinguished traveller.

JUBILEE NEWS from Holland will be recounted in Dutch for Colonial listeners by Mr. K. D. Koninly.

On Tuesday, May 7th, Radio Paris will relay Raynal's play "Napoléon Unique" from the Comédie Française at 8.30.

A GOOD TITLE

VAGABOND songs and folk music will be heard in Leipzig's Folk Play, to be broadcast to-morrow evening (Saturday) at 8.10. The programme should be worth waiting for. Listen for the title: "Lumpacivagabundus."

OPERA ABROAD

WITH Covent Garden Opera in full swing, listeners may be disinclined to seek opera abroad, but there are several items deserving of comment.

To-night (Friday), at 9.10, Beromunster will relay Korngold's opéra-comique "Der Ring des Polykrates," with the Berne Municipal Orchestra conducted by Lertz. From the same station to-morrow, between 8.15 and 10.0, comes Handel's opera "Xerxes," relayed from the Hans Hube Hall, Basle.

Coming within the category of opera is Massenet's three-act oratorio "Marie Magdeleine," which will be broadcast by Bordeaux-Lafayette on Wednesday, May 8th, the station orchestra and St. Cecilia Choir taking part. Also on May 8th Kalundborg will relay Wagner's "Tannhäuser," Acts II and III, from the Royal Theatre, Copenhagen. And on the same evening Toulouse offers us Massenet's "Werther" from 8.15 to 11.10.

THE BRUSSELS EXHIBITION

TO-NIGHT (Friday) one can tune in direct to the International Exhibition at Brussels. A relay will be provided by Brussels No. II of a symphony concert at the Exhibition.

"SEA-DAY" festivities will be broadcast from Warsaw this evening. These Polish highlanders from the Carpathian mountains visited Warsaw for similar celebrations last year.

INTRADAS

MUSIC composed 400 years ago will be heard in the Leipzig Symphony Concert to-night (Friday) between 10.30 and midnight. The programme includes three Intradas from "Venus-Kranzlein," by Johann Herman Schein, who was born in 1586. In 1615 he was appointed Cantor to the famous Thomasschule in Leipzig, and held this post till his death in 1630.

LF Amplification in Television Receivers

(Concluded from page 419 of April 26th issue)

Designing an Amplifier

IN the previous instalment the theoretical considerations underlying the design of a television amplifier were dealt with and the importance of the valve capacities was stressed. The design is carried a stage further in this article, and the difficulties attendant upon obtaining the required frequency characteristic together with an adequate output are discussed.

By W. T. COCKING

THE difficulties attendant upon the use of triode valves in the modulation-frequency stages of a television receiver were discussed last week, and it was shown that these largely disappear if screen-grid valves be used. Even then it is necessary to resort to special corrected couplings, and a series of curves was given which, with the formulæ which accompany this article, enable the design to be rapidly carried out. It will be found, however, that although there is no difficulty attached to the attainment of an even response, even at the highest frequencies required in television with a stage gain of a satisfactory, but not high, order, this involves the use of only a moderate load resistance on the valve. Consequently, the maximum undistorted output obtainable is somewhat restricted. This is of little importance in the case of early stages where the output required from the valves is small, but it may be prohibitive in the last stage. This stage feeds the cathode ray tube and should give an output of some 28 volts peak for an average high vacuum tube. Now, if the stage gain is 16 times only, the input to this valve must be $28/16 = 1.75$ volts peak, and the normal operating grid bias for the MSP4 is 1.75 volts. To be free from any risk of grid current, however, the input cannot exceed about 0.75 volt peak, so that we cannot safely operate with a lower stage gain than 38.6 times, which means a load resistance of about 20,000 ohms. We shall be wise, therefore, in choosing the optimum value of 25,000 ohms, with which the stage gain is 50 times, for then the input is only 0.56 volt peak, and there is no danger of grid current.

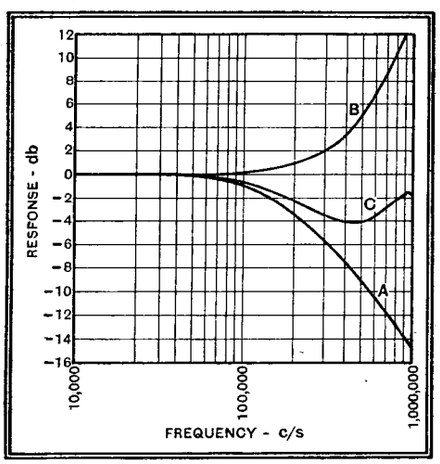


Fig. 7.—Curve A shows the response of the uncorrected output stage, and B that of an overcorrected penultimate stage, while curve C represents their combination.

The response curve of the last stage will then be like curve A of Fig. 3, reproduced in the previous instalment, and if we are to obtain a flat overall response from our amplifier the preceding stage must not be flat, but have a rising characteristic. A certain amount of trial and error must enter the design at this point. The loss at 1 mc/s is 14.9 db., so that we must choose a characteristic for the preceding stage which rises by about this amount. Fig. 5 shows that when $L/CR^2 = 4$ the rise is 13.0 db. at $f/f_1 = 1$. This response curve replotted on a frequency basis for a resonance frequency of 1 mc/s is shown by curve B of Fig. 7, in which curve A is for the last stage. The combination of the two curves gives the results shown at C, with a total gain for the two stages of 220 times. Even now, however, the response is not very good, for although the loss at 1 mc/s is only 1.8 db., there is a drop to 4.2 db. at 450 kc/s.

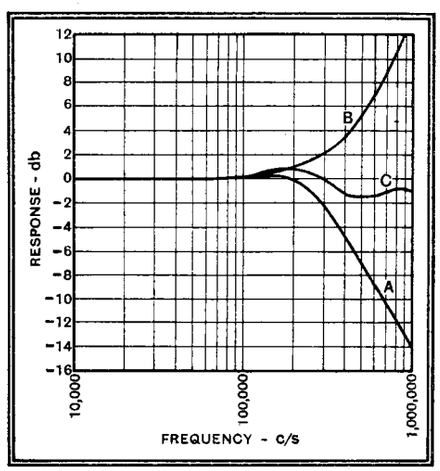


Fig. 8.—Curve A is for a corrected output stage with R = 25,000 ohms and L = 10,900 μH., while B and C are respectively the penultimate stage and the overall with L = 725 μH. and R = 2,200 ohms.

Now, we cannot readily avoid this type of characteristic when using only a single correcting stage preceding the output valve, for the *shapes* of the response curves of the different stages are not complementary. We cannot properly correct the output stage, for the load resistance must be maintained at a fairly high value. We can, however, apply a small measure of correction. Suppose we try $L/CR^2 = 0.5$, which gives the flattest response (Fig. 5). Knowing R^2 we can calculate L/C, and, as C is known, we obtain the value of L. We can then find the resonance frequency for which $f/f_1 = 1$, and it is 262 kc/s. The response curve is then A of Figs. 8, 9, and 10. Curve B of Fig. 8 is for the same preceding stage as before, and curve C gives the new combination; a definite improvement is evident, but it is still not as good as we should like.

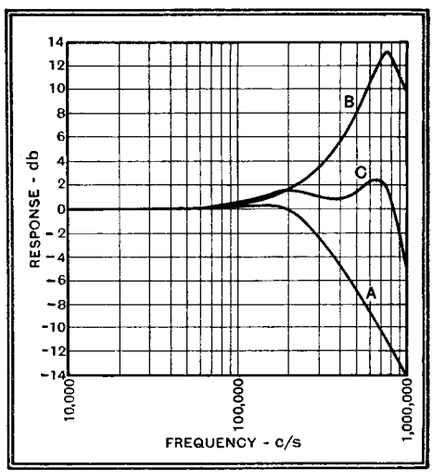


Fig. 9.—Curve A is the same as in Fig. 8, but, in curve B, L = 1,286 μH. and R = 3,000 ohms. This gives the overall response of curve C.

The Corrector Stage

It is usually better to have a greater drop at the highest frequency and a more even response at lower frequencies. Let us try, therefore, peaking the first stage at 750 kc/s instead of 1 mc/s; the response of the first stage is given by curve B of Fig. 9 and the overall response by curve C. The total gain has now risen to 300 times, but the characteristic is still not very satisfactory, for the loss at 1 mc/s is some 5 db., and there is a rise of 2.2 db. at 650 kc/s. It is evident that the corrector circuit is now resonating at too low a frequency, so let us try 850 kc/s.

LF Amplification in Television Receivers—

The results are shown in Fig. 10, in which, as before, curve B represents the first stage and curve C the overall characteristic. It is evident that we have now found a combination which is likely

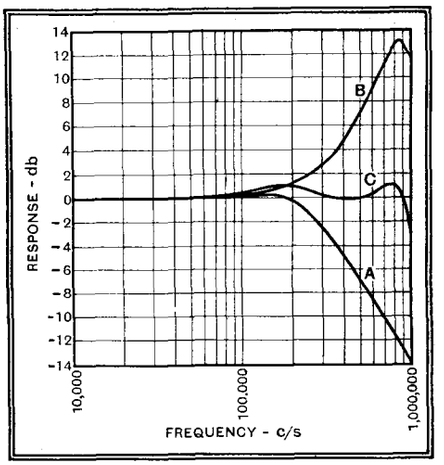
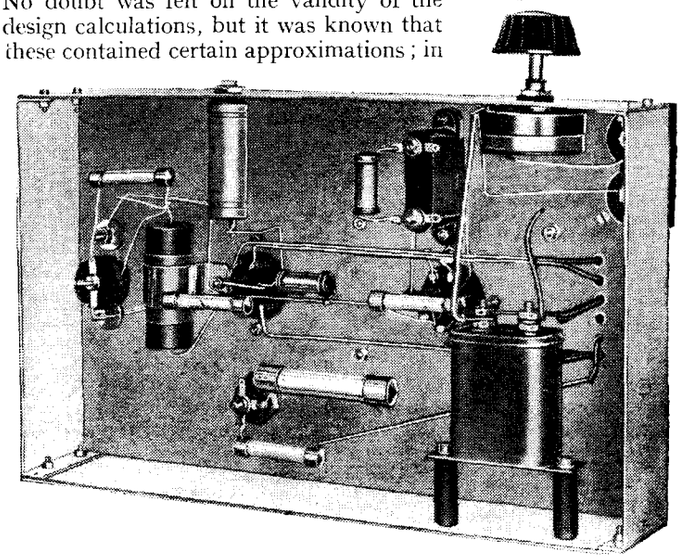


Fig. 10.—Curve A is again the same as in the preceding illustration, but curve B is now for values of L = 1,000 μH. and R = 2,670 ohms, and curve C represents the overall characteristics.

to meet even exacting requirements. The response is even up to 50,000 c/s, after which it rises gradually to a maximum of +1.2 db. at 175,000 c/s; it then falls to a minimum of −0.2 db. at 450,000 c/s, after which it again rises to +1 db. at 800,000 c/s. The fall at higher frequencies is rapid, but at 1,000,000 c/s it is only −2.9 db., so that it is clear that this combination is likely to be highly satisfactory.

In order to check the design an amplifier was built embodying components of the values which have just been calculated and its circuit diagram appears in Fig. 11. No doubt was felt on the validity of the design calculations, but it was known that these contained certain approximations; in particular the self-capacity of the correcting coils has been ignored, and it would not be quite accurate to treat it merely as increasing the general circuit capacity owing to the presence of the coupling resistance. Moreover, in any practical amplifier unsuspected effects are likely to be found, and feed-back through stray couplings might appreciably modify the characteristics.



An under base view of the experimental amplifier. Note the insulating mounting of the metal-cased fixed condenser to avoid the effect described in the text.

When first tried out the amplifier of Fig. 11 gave the measured response curve A of Fig. 12 for frequencies above 10,000 c/s with a gain of 196 times, and this is obviously very different from the calculated curve C of Fig. 10. The discrepancy was far too great to be ignored, and in order to find out where the trouble lay the characteristics of the output stage alone were measured and found to exhibit a similar departure from the expected values. The reason was discovered to lie in the fact that the stray capacity across the output circuit was 64 $\mu\mu$F instead of the value of 35$\mu\mu$F assumed in the calculations.

The input capacity of the valve voltmeter employed for measuring the output voltage was known to be 15$\mu\mu$F, but this was intended to be included in the 35$\mu\mu$F for the total capacity, since in normal operation the cathode-ray tube will have about this capacity with its associated wiring. A search for the cause of the high stray capacity, therefore, was confined to the amplifier, and two points were brought to light which well illustrate the need for care in the construction of television amplifiers. The component used for the output coupling condenser C_1 (Fig. 11) was of the metal-case type, and measurement showed it to have a capacity of 23$\mu\mu$F between its terminals and the case. The metal case was earthed by its contact with the chassis, so that this 23$\mu\mu$F was fully effective in augmenting the stray capacity. On changing this condenser for one of the bakelite-case type the response curve B of Fig. 12 was obtained, and a comparison with curve A well illustrates the need for care in the choice of components.

The stray capacity was still high, however, being now 41$\mu\mu$F, and the cause of this was found to lie in the arrangements made for the output connections. A multiway terminal-connector was used and the high-potential output terminal was sandwiched between two at earth potential. Omitting the terminal entirely and using in its place the condenser terminal on C1 itself reduced the capacity to a figure slightly below 35$\mu\mu$F. The complete response curve then took the form shown in Fig. 13, and although it still exhibited some variation from the calculated response, this was not considered serious enough to warrant further investigation.

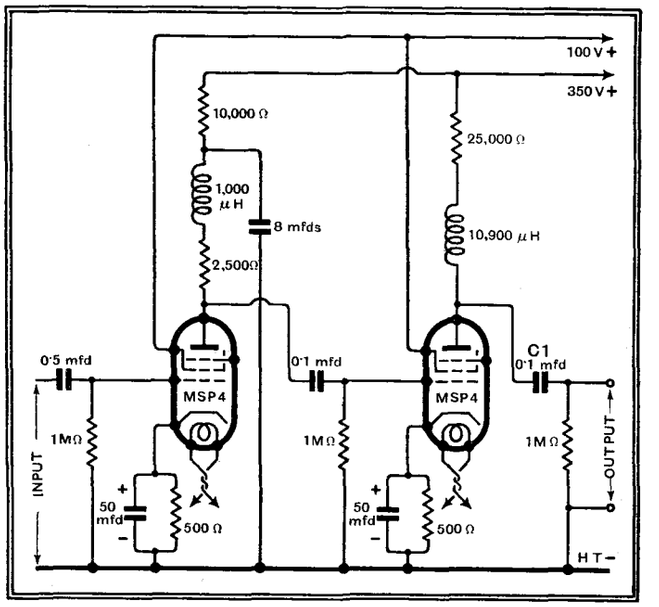


Fig. 11.—The circuit diagram of an experimental amplifier. With the values of components shown, the frequency characteristic is that of Fig. 13.

This curve is very satisfactory indeed, for the amplifier employed is in no way complicated, and the only components used which would not be needed in a similar amplifier for sound purposes are the two correcting chokes, which should not cost more than a few shillings. At the low-frequency end the response commences to fall at about 100 c/s, but it does not drop below 1.8 db. even at 20 c/s. This is particularly interesting in view of the fact that it has been stated that cathode biasing cannot be used with HF

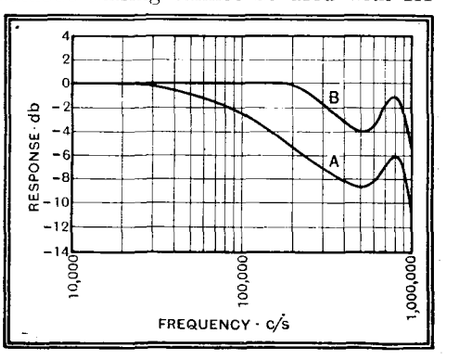


Fig. 12.—These curves represent the initial response with the amplifier of Fig. 11, and the high-frequency attenuation is due to excessive stray capacity in the output circuit. The substitution of a bakelite for a metal-cased condenser, C1, altered the response from curve A to curve B.

LF Amplification in Television Receivers—

pentode valves if a good low-frequency response be required. The curve of Fig. 13 shows that there is no difficulty in maintaining the low frequencies if 50μF electrolytic condensers be used to by-pass the bias resistances.

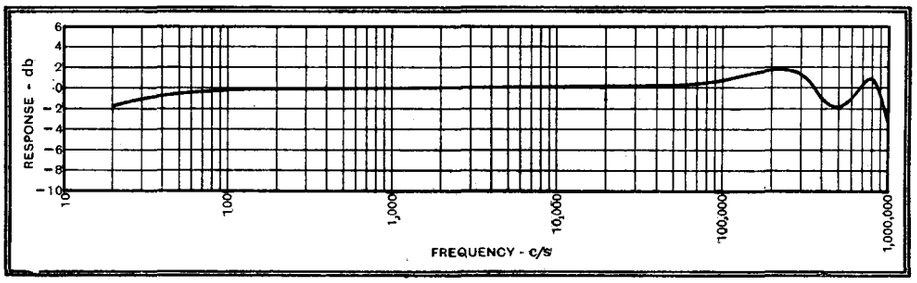


Fig. 13.—The final response of the amplifier is shown here, and it is flat within ± 2 db. from 20 c/s to 900,000 c/s.

At higher frequencies the curve is level up to 50,000 c/s, beyond which it rises gradually and reaches a maximum of +1.8 db. for frequencies of 200,000 c/s to 250,000 c/s. The response then falls to a minimum of −1.8 db. at 500,000 c/s, after which it again rises to +0.8 db. at 800,000 c/s. For frequencies higher than this the output steadily falls, and at 1,000,000 c/s the loss is −3.6 db. The characteristic is actually better than it appears at a cursory glance, for one is at first apt to pay too much attention to the variations at high frequencies. The response is even within ±1.8 db. (a maximum variation of 3.6 db.) over the enormous range of 20 c/s to 940,000 c/s. A variation of this order over the range of 50 c/s to 10,000 c/s is often considered good in a sound amplifier, but the ratio of maximum to minimum frequencies is only 200-1 compared with the ratio of 47,000-1 for the television amplifier!

Before concluding, it may be as well to summarise the chief points which arise in the design of television amplifiers:—

(1) Triodes cannot be used easily on account of their low input impedance at high frequencies.

(2) Even with screen-grid or HF pentode valves, simple corrector circuits are necessary.

For the circuit of Fig. 4 the following formulæ apply:

At low frequencies:

$$A = gR \qquad (1)$$

Where A = stage gain.
g = mutual conductance (A/Volt)
R = resistance in ohms.
C = stray circuit capacities. (usually about 35$\mu\mu$F) in farads.
L = inductance in henrys.
f_1 = resonance frequency, c/s.
$\omega_1 = 2\pi f_1$

Choose the values of L/CR^2 and f/f_1 for the response required from Fig. 5, f/f_1 being for the maximum tolerable drop at the highest frequency required. The resonance frequency f_1 is then the highest frequency required divided by the value of f/f_1, and

$$L = 1/\omega_1^2 C \qquad (2)$$

then R can be found at once from the value of L/CR^2 selected.

(3) The most even response is obtained by correcting each stage individually.

(4) When the output valve must be operated with a high load impedance to avoid amplitude distortion, full correction in this stage is impossible, and the overall response must be maintained by correcting a preceding stage. The response is not then as flat as in (3), but can usually be made very good.

(5) At low frequencies the design follows normal practice, and no special precautions are necessary. Cathode biasing can be used.

(6) Care must be exercised in the choice of layout and components in order to keep stray capacities at a minimum.

No mention has been made of phase distortion in this article, in spite of the fact that this may prove important in television reception. It is likely to occur at both low and high frequencies, and the correction circuits employed for maintaining an even response also tend to correct for phase distortion at high frequencies. In general, however, the degrees of correction necessary for a minimum of both types of distortion are not the same. At the present time phase distortion seems less important than the maintenance of an even frequency response, but there is no doubt that it will have to be considered in the future, and the writer hopes to deal with some of its simpler aspects in a further article.

High Fidelity

Tribulations of the Set Designer

By "CATHODE RAY"

WHEN we engineers are surprised at our work by non-technical intruders they point to the upended receiver chassis with all its exposed entrails, and in various fatuous terms express their wonder at the vast intelligence that is able to cope with such dark mysteries. While gratefully accepting the compliment for what it may be worth, we know quite well that our real problem is not *how* to design; it is to know *what* to design.

Sales managers are reviled for taking bigger salaries than the men who do the productive work; but if they succeed in finding out what their customers really want they are worth all their lions' share. Then, it is simply a matter of doing the job; and, of course, the engineer can always be counted upon for that, if he isn't hustled too much.

As for the sales manager, poor wretch, he is in exactly the position of the Chaldeans, the astrologers, the sorcerers, and the soothsayers, when they were commanded to interpret the dream of King Nebuchadnezzar, who, you remember, was totally unable even to relate to them his dream. So when a Daniel appears it is only fitting that he should be richly rewarded, even to being appointed third on the Board of Directors.

Suppose the technician, who is not gifted with a spirit of divination, tries to meet the need of the public direct. A Man in the Street, who thinks it would be great fun to hear broadcasts from the more remote and uncensored parts of Europe, tells him he wants a powerful receiver. To an engineer a powerful set is one giving a large output power—a big noise, in fact; and very often this type of receiver has only a very moderate range, or it may even be designed for local station reception. So here is a bad misunderstanding at the start.

Or perhaps the designer takes it almost for granted that people want reproduction as true to the original as possible. Having lavished all the skill of his craft in achieving this, he is grieved to find that his product is rejected in favour of a competitive set that gets a few more stations or is a few shillings cheaper. And when he asks if the superbly faithful quality of his receiver does not count for something in its favour he is told that the other is "good enough," or perhaps even better, because it is "mellower" and freer from hiss and sideband splash. All the time he could have given them that (at some sacrifice of conscience, perhaps) if only he had known!

No; the commercial designer is wise to work on the clear understanding that he is responsible for producing what his firm's sales staff ask him to produce, and not for interpreting the public demand.

What We Want

That demand is as capricious and elusive as the obscurer phenomena of radio appear to the uninitiated. It is a strange thing that I, and all the people I know, and the people *they* know, unanimously want receivers giving good reproduction, and regard the reception of foreign stations as a secondary consideration. And yet—contradict me if you can—*no short-range high-quality receiver intended for quan-*

High Fidelity—

tity production has ever been a commercial success. There is a gratifyingly large specialised demand; but all the nationally advertised (and *sold*) brands are intended for range first.

I have already[1] had something to say on the apparent preference for bad tone (judged by technical standards). Now we are beginning to hear a lot from America about "high fidelity." One wonders whether it is a genuine trend towards better quality of reproduction, or merely a device for combating "sales resistance." If it becomes generally noised abroad that high fidelity is the latest and best thing to have, then you may be sure that all sets will have to have it, quite independently of what they really are. That is rather unfair on those manufacturers who really do provide high-fidelity reproduction; because their sets, being more expensive, will not sell like others that are burdened only by the name. Still, it will be a "high-fidelity" year, no doubt.

Whatever is done within the receiver—and quite a lot can be done—there is always the handicap of a restricted audible frequency scale; the stations are crowded together so much that if the valuable top octave is received it is almost invariably defiled by strange mutterings and janglings, or, perhaps, even by Nazi imprecations.

How it Can Be Done

There are two ways of having really good quality of reproduction. One is to live close to a main broadcasting station, so that no other transmission is strong enough to cut into any part of its radiated frequencies. The receiver has to be properly designed, of course; but that is at least a possibility.

The other is to redistribute all the wavelengths of Europe so that they are two or, preferably, three times as far apart as they are now. Technical men would do it to-morrow—or perhaps even to-day. Political considerations, national prestige, and so forth, are the controlling forces, and technicians have no say in these matters.

There is a variation of the second method which almost deserves to be regarded as a third. It has been referred to several times in this journal—the single-sideband system of transmission. By suppressing one of the two sidebands that carry the programme in the existing system double the space is left for the other, and one appears to get, by a technical device, the scope for full-tone reproduction that the politicians withhold.

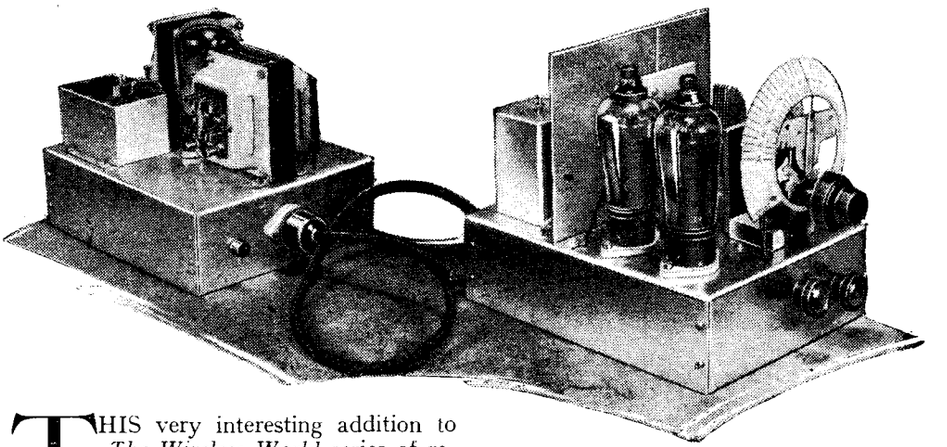
The word *appears* is used deliberately. I was speaking to a very famous broadcast engineer who was enthusiastic about single sideband, and ventured to suggest that the politicians might see in it a chance not to double the quality of transmission but to double the number of stations. He looked hard at me. "The ——s *would*!" he said.

[1] "Why do Listeners Like Boom?" *The Wireless World*, Feb. 1, 1935.

"The Wireless World" AC Short-wave Converter

A Test Report Conducted at Our Invitation

By "MICROM"

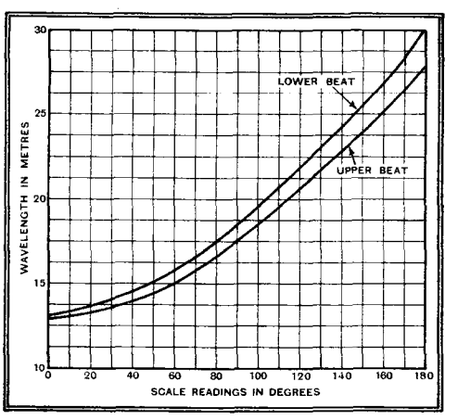


THIS very interesting addition to *The Wireless World* series of receivers and converters was received on loan on Saturday afternoon, April 13th, and was immediately put into service in conjunction with a simple AC receiver employing 2 HF stages with AVC and a double-diode output pentode delivering, when fully loaded, about 3 watts to a moving-coil loud speaker.

Although conditions were very poor on Saturday afternoon, sufficient stations were tuned in at comfortable to full loud speaker strength to enable an accurate calibration chart to be drawn up for both ranges.

Among the stronger stations received were DJA on 31.38 metres and DJN on 31.45 metres—both of which were giving signals of excellent entertainment value.

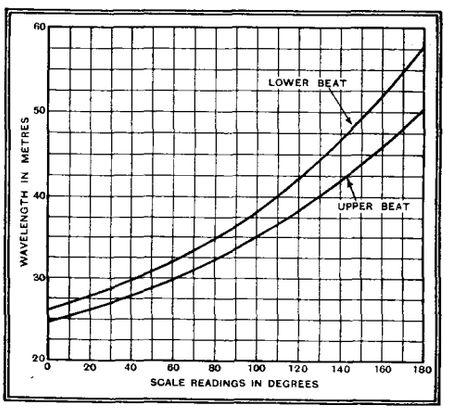
Just after 5 p.m.—two of the U.S. stations carrying the "Five Hours Back" relay were heard successfully—but rather weakly—they were W3XAL on 16.87 metres and W2XAD on 19.56 metres, but it was interesting to note that even the B.B.C. were having some difficulty in relaying on this occasion.



Wavelength calibration of the oscillator on range one with an IF of 450 kc/s.

A more extensive test was made on Sunday, having now calibrated the receiver, and at 4.30 p.m. really excellent, perfectly steady signals were obtained from DJE on 16.89 metres.

What appeared to be LSL on 14.18 metres, the 'phone station at Hurlingham, Buenos Aires, was also tuned in at 32 deg. and GSG on 16.86 metres, directive eastwards of Daventry, could just be heard below DJE. There appeared to be no lack of sensitivity on the lower end of



Range two oscillator calibration using an IF of 450 kc/s.

Range 1—as is often the case with short-wave receivers—but numerous 'phone channels and commercial Morse stations were tuned in below 17 metres.

Towards the top of Range 1 Moscow, on 25 metres, was an excellent signal—and PHI and GSE were fairly good signals round about 5 p.m.

On Range 2 in the early evening, in spite of the poor conditions still obtaining, numerous short-wave broadcasters were tuned in, the best being VK2ME on 31.28 metres, at about R7—100 per cent. intelligible, Rome, on about 31.13 metres,

AC Short-wave Converter—

R9+, excellent, OXY on 49.5 metres, a very good signal, 100 per cent., and many others.

Later in the evening WIXK (formerly (WIXAZ), on 31.35 metres, was picked out, the 31-metre group at fair strength round about 11.30 p.m., and at this time both DJA and DJN were enormous signals, DJN, incidentally, appeared to be radiating two carriers—both modulated—and located below the 31-metre band.

Many signals were tuned in on both the 20- and 40-metre amateur bands.

With only one signal frequency tuning circuit and a fairly low IF frequency some second channel interference was bound to be present on a few stations, but in no case was it serious, and in this respect the converter compared very favourably with other types used by the writer.

There was also, too, a tendency for the grid circuit trimmer to change the frequency of the oscillator, but this effect was not sufficiently pronounced in any way to spoil the performance of the converter, which was generally easy and simple to operate and should be well suited to the needs of many *Wireless World* readers.

Short-wave Broadcasting

Growing Popularity in the United States

A LONG and interesting letter from a colleague in the United States brings up several intriguing points connected with short-wave broadcasting. The different attitude towards short-wave reception over there comes as rather a shock to one who has become thoroughly steeped in the British views of the short waves.

In the States the average owner of a broadcast receiver has no foreign programme of any kind available to him. A short-wave receiver, therefore, brings in a completely new set of stations and the handling of it becomes a truly thrilling business. Here, in this country, many of the short-wave stations that we hear are merely old friends on a new wavelength; and, in any case, reception of foreign programmes is such a commonplace event that none of us think anything of it.

Our main interest here in short-wave broadcasting is undoubtedly the reception of programmes from America and Australia. Several *Wireless World* readers have openly stated that their sole reason for the maintenance of a short-wave receiver is that they want to hear Amos 'n' Andy, and, perhaps, Father Coughlin! This, admittedly, cannot be done with any sort of reliability on the medium wavelengths.

The extraordinary vogue that the short waves are enjoying in the States, however, is undoubtedly due to the fact that it is their one chance of receiving foreign stations; and they certainly appear to be making the most of it. Radio periodicals over there are full of lists of "short-wave scouts" and short-wave baronets," who claim to have achieved wonderful long-distance feats, and they are fast usurping the position once held by the "wireless expert" who knew all about the valve and how it worked!

Commercial short-wave receivers are listed in their hundreds, whereas in this country the few firms who manufacture them intend them chiefly for export. Perhaps one day when all local broadcasting is carried out on ultra-short waves with a limited range, *our* only hope of receiving the Europeans (even if we want to!) will be to go up to the short waves. Who knows?

Conditions during the past fortnight have been extremely good, especially on the shorter waves, and the 19- and 25-metre bands have been productive of very strong signals from America with great regularity. Pittsburgh (W8XK) still stands out above all the other American transmissions.

Incidentally, one does not often see references to the truly excellent *quality* of the average American transmission. A high-quality receiver is becoming more and more worth while for the short-wave listener, especially as he is not often likely to be troubled with 9-kc. beat-notes.

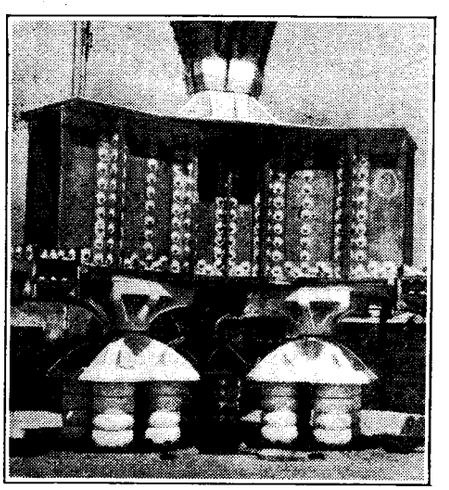
It is, of course, a simple matter for the transmitter to make full use of the large amount of "spread" that is possible, but the receiver (generally by the excessive use of reaction) rather spoils the picture.

This in itself is a strong argument in favour of the use of HF amplification, which reduces the tyranny of the reaction control as well as making the handling of the receiver more pleasant in other ways.

New stations heard recently include XAM, a Mexican, on 26 metres at mid-day; COH, Havana, in the 31-metre band during the evening; HJ1ABH, a new Colombian station, in the 49-metre band late at night; and several unidentified stations which are being closely watched.

The 49-metre band is becoming rather "full" during the evenings on account of the tremendous strength with which some of the European stations come in. This same shortening of the skip-distance has been noticeable on the amateur bands.

MEGACYCLE.



A STUDY IN INSULATION. A close-up of the base of one of the giant aerial masts at the Telefunken short-wave station at Nagoya, Japan. The station maintains a regular telephone service with Berlin.

In Next Week's Issue:—

Modulated Test Oscillator

Self-contained Screened Oscillator of Wide Range

THE adjustment of the modern receiver is greatly facilitated by a modulated oscillator which can be adjusted to provide a signal of controllable strength and of any desired frequency. Complete screening of the equipment is necessary if the signal is to be applied to the receiver at the desired point only, and this is most readily achieved by including the whole apparatus, with its batteries, in a metal container, and by employing screened output leads.

The range covered is 100-1,750 kc/s in four bands with built-in coils, so that there is a signal available throughout the whole of the two broadcast bands, and also at the intermediate frequency employed in a superheterodyne. Not only are low intermediate frequencies in the neighbourhood of 100-130 kc/s catered for, but frequencies in the region of 450-465 kc/s, which are becoming more widely used, while the range also extends to the high frequency used in single-span receivers. Calibration is readily carried out.

The modulation is obtained by a separate valve, and a switch is provided to give an unmodulated output when required. The HT battery is of 16½ volts only, and the total current consumption under 1.2 mA., while reliable oscillation can be secured with a voltage no greater than 9 volts, so that ample allowance is present for falling battery voltage. A small unspillable accumulator is used for LT.

LIST OF PARTS

1 Two-gang condenser, 0.0005 mfd.	**Polar "Minor"**
1 4in. length ¼ in. shaft and shaft connector	**Bulgin**
1 Dial (General Radio Type 703A)	**Claude Lyons**
1 Coil assembly (see text)	
1 Choke, 3 henrys, tapped	**Varley DP18**
1 HF choke	**Bulgin HF10**
2 Metallised resistances, 100,000 ohms, 1 watt (Amplion, Erie, Ferranti, Graham Farish, Claude Lyons, Polar-N.S.F., Watmel)	**Dubilier**
1 Wire-wound potentiometer, 5,000 ohms	**Claude Lyons Clarostat M-5**
2 Fixed condensers, 0.0001 mfd.	**T.C.C. Type M**
2 Fixed condensers, 0.01 mfd.	**T.C.C. Type M**
1 Fixed condenser, 0.2 mfd. (Dubilier, Graham Farish, Peak, Polar-N.S.F., T.M.C. Hydra)	**T.C.C. Tubular Type 250**
1 Rotary switch, single-pole, 4-way	**Kabi**
2 Toggle switches, on-off (Bulgin)	**Claude Lyons 728**
2 Valve holders, 4-pin, baseboard mounting	**Eddystone 949**
2 Grid battery clips	**Gripso 36**
2 Wander plugs	**Eelex**
2 Spade terminals	**Eelex**
1 Screening cabinet	**Eddystone 975**
1 yard Screening sleeving	**Goltone**
2 Crocodile clips	**Bulgin CR6**
1 Accumulator, 2 volts, 12 amp.-hr., unspillable	**Ever Ready S121**
1 GB Battery, 16½ volts	**Drydex**
Valves: 2 Cossor 210 LF.	

BROADCAST BREVITIES

By Our Special Correspondent

Tape or Disc ?

WHILE experts at home learnedly discuss the relative merits of the different systems of recording for Empire broadcasting purposes, a letter reaches me from a correspondent who deserves a hearing, if only because he lives in far-away Singapore.

"From my observations," he writes, "the hiss in a steel tape recording increases with each replaying. Disc recording is certainly better, and, under short wave conditions, indistinguishable from the original. Could not the B.B.C. use disc recording for the Empire broadcasts?"

The Engineers' View

Contact with B.B.C. engineers has led me to believe that they are actually in favour of discs themselves, and several types are being experimented with at the moment. The trouble, of course, is that the ordinary disc has such a short playing time, necessitating the use of a stop watch and extreme care when attempting to obtain the effect of continuity.

One spool of steel tape will run for twenty-five minutes, in the manner of a talkie film.

Future of Film Recording

And, while on the subject of films, it is worth mentioning that the engineers have high hopes that the coming of television will provide a good excuse for switching over exclusively to film recording. Film will be used for most television broadcasts, both for first performances and also repeats. What could be more logical than to use film sound tracks for ordinary sound programmes, seeing that the necessary recording equipment will be *in situ* at Broadcasting House?

The Empire Orchestra

My Singapore friend puts in a good word for the B.B.C. Empire Orchestra, which, under Eric Fogg, has been pursuing a somewhat surreptitious existence since it was founded last autumn, although its leader is none other than the famous Melsa.

"I find," he writes, "that my premature criticisms of the Empire Orchestra were unfounded, for they are showing themselves to be an excellent musical combination. Their programmes are very well chosen with a view to suitability for short-wave broadcasting, for they never play very 'heavy' music."

They Want to Listen

This is, of course, one man's opinion, but I have a feeling that it represents the view of a large number of short-wave Britons abroad who are anxious to make the British programmes the mainstay of their broadcast entertainment, despite the blandishments of thinly disguised propaganda transmissions from other countries.

The Language Question

Last week I spent several half hours listening to the English broadcasts from Zeesen. So far as I could make out through a haze of atmospherics, the "news" was innocuous enough, consisting of isolated sentences from British newspapers which might be construed as favourable to the Fatherland. But why is the bulletin in English?

Suppose Daventry were to start up to-morrow in German, or Russian, or Polish?

Would the countries concerned extend the right hand of fellowship, or the frozen mitt?

Free Jubilee Music

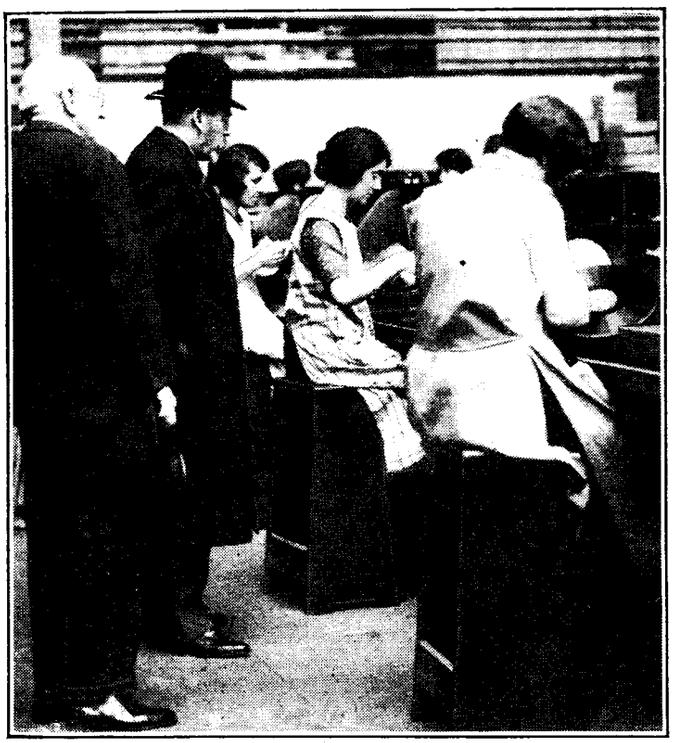
THE Performing Right Society has joined hands with the B.B.C. in permitting owners of wireless sets to rediffuse copyright music broadcast during Jubilee week.

"It should be noted, however," states the B.B.C., "that any descriptions of the scene outside St. Paul's Cathedral on the occasion of the Silver Jubilee on May 6th must not be rediffused to the public anywhere along the route by which the Royal Procession will pass east of Charing Cross station."

Television in Jubilee Week

LOW definition television programmes go by the board on Monday next, Accession Day, and there will be only one television programme from Broadcasting House during the week, viz., on Wednesday, when an attractive bill is promised.

In addition to songs by Marie Dayne, and "Bits and Pieces" by Leslie Childs, there will be Gus Chevalier, the comedian, Anna Marita, the ballerina, and the Macdonald Dancing Twins.



THE KING'S INTEREST in radio extends to the manufacturing processes. This photograph was taken when His Majesty visited the H.M.V. factory at Hayes and watched radiograms and records in the making.

Tantalising

Many of these television programmes can be thoroughly enjoyed as ordinary sound broadcasts on the 296.6-metre wavelength, but there are some tantalising items that make one want to tear the back out of the loud speaker.

Would it be adding insult to injury to ask Eustace Robb to deliver running commentaries for the sake of listeners who have not bothered to install television equipment?

Acoustics of St. Paul's

AS was first mentioned in these columns many months ago, the B.B.C. engineers have spent a good deal of time in St. Paul's Cathedral in their endeavours to overcome the execrable acoustic shortcomings of Wren's masterpiece.

The results will be apparent on Monday next, though it is not only with the Thanksgiving Service that the engineers have been concerned. Actually, Monday's great event will be the precursor of regular broadcasts from the Cathedral for the benefit of Empire listeners.

Cathedral Services for the Empire

June 9th next will see the first of a series of special services arranged by the Dean and Chapter in co-operation with the B.B.C. These will be held on the second Sunday of each month at 2.15 p.m., and added importance will accrue from the fact that it is intended to assemble, by means of a special appeal, a congregation drawn from the relatives and friends of persons resident in various parts of the Empire.

Broadcasting from the Zoo

THE annual visit which the Zoo Man and Uncle Mac pay to the Zoological Gardens takes place on May 21st, when the Reptile House will again be the control point for a network of cables and microphones.

The engineers long ago abandoned the "wireless pram," which paraded the grounds to provide a wireless link between the animal artists and the B.B.C. control room. The chimpanzees and baboons now add to the ties of kinship a direct cable connection to Broadcasting House.

UNBIASED

By FREE GRID

An improvised aerial.

On the Kerbside

I HOPE that all of you who intend to come up to London to view the Jubilee processions are not forgetting to equip yourselves with vest-pocket headphone portables. Loud speakers are provided for those fortunate individuals who are opulent enough to loll in lordly state in one of the stands, but for poor people like you or me who find ourselves hard put to it to meet the bookmaker's weekly account nothing is being done and we are to be left to shift for ourselves.

The enjoyment of seeing the processions will be greatly enhanced if people on the kerbside can listen to the commentators' description of the various personages and scenes. These commentators are to begin work at breakfast time and so the weary hours of waiting will be pleasantly whiled away. I think, however, that the B.B.C. are making a grave mistake by not broadcasting programmes throughout the preceding night. From personal experience of the Coronation in 1911 I can vouch for the fact that crowds will commence to assemble long before midnight on the preceding night, and no better opportunity could exist for popularising broadcasting than a cheerful all-night vaudeville.

However, I do strongly advise my readers to leave nothing to chance. If they will equip themselves with a vest-pocket portable I do assure them that they will be infernally grateful to me for the suggestion, for there will be plenty of foreign programmes to listen to until a very late hour, even if some of the "sponsored programme" stations do not seize the opportunity to put special all-night English programmes on the air.

Apart from this, it must not be forgotten that American time is several hours behind ours and a short-wave set will do wonders, more especially as there are literally hundreds of flag poles in which a drawing pin can be stuck to attach an improvised aerial. In connection with the latter, I well remember that during the Coronation festivities I was able to put into practice the dart-throwing skill obtained by long sessions in many of our ancient hostelries and astonish the people round about me by slinging up a wire and receiving Eiffel Tower time signals on a crystal set, although strangely enough, I caused more interest by playing a portable gramophone of my own design and construction, such things being then, I believe, quite unknown.

Well, don't forget to look out for me in the crowd.

These Voice Filters

SOME inventors never seem to be happy unless they are delving into the whys and wherefores of various human shortcomings and seeking means wherewith to overcome them. The latest instance of this is a learned professor who, so he says in a letter, was much struck by the unintelligibility of the accent of the local inhabitants while staying recently in a Northern seaside resort.

Probably if he had mentioned the matter to one of the aforementioned inhabitants he would have been struck with something else besides their accent. However, I think I know what he means, for I have suffered myself, at times, even though, having an aunt who was born in Blackpool, I might be expected to comprehend some of the lingo.

Comprehensible to those of other parts.

But we will let the Professor speak for himself.

"Patient and prolonged investigation in my laboratory," he writes, "has revealed to me that Northerners are incomprehensible to me and my fellow-Southerners because their speech suffers from severe high-note attenuation. Upon discovering this state of affairs I hastily rigged up a microphone and special amplifier fitted with a high-note booster of my own design, and, on inducing a native from those parts to speak into the microphone, I was enabled after a little adjustment to cause the sound of his voice to be indistinguishable from that of a B.B.C. announcer.

"Further experiment disclosed that the accent of certain B.B.C. announcers is often offensive to Northern natives simply because their voices are unduly rich in high notes. By the use of a high-note attenuator I was able to correct this and go even further and cause the announcer's voice to sound like that of my Northern assistant. By thus finding the common denominator of the English language I hope eventually to produce a portable filter unit which, when used by an inhabitant of any part of England, will enable him to be comprehensible to those of other parts."

It is noteworthy that the learned professor preserves a discreet silence on the subject of Welsh and Scotch, and I can only presume that these languages contain spurious frequencies which may be likened to the filter-passing virus of many diseases which continue to baffle medical science. For my own part I strongly resent these attempts to interfere with the rich accents and idioms of our local dialects and thus produce an emasculated, uniform and simpering sort of language such as the B.B.C. Advisory Committee would like to foist on us. The first time that the B.B.C. attempt to use one of these filters in the control room I intend to give up my licence.

Slackness

IT is astonishing how increasingly slack people seem to be getting concerning the necessity of strict accuracy in their written and spoken statements, a matter about which most of us were very painfully instructed in the days of our youth.

I am not thinking so much of honest, straightforward lies as to those little half-truths, petty inaccuracies and terminological inexactitudes to which most people seem becoming increasingly addicted. As everybody knows, the great feature of this Jubilee year is the publication of books dealing with the history of the past twenty-five years, and the showing of exhibits depicting, pictorially or otherwise, the progress in various branches of human activity since 1910. Such exhibits deal with a multitude of subjects, including aviation, wireless, gramophones, medical science and suchlike things.

Only recently I was at one of these shows and immediately several examples of glaring inaccuracy struck me in the eye. The subject dealt with was, of course, wireless and its allied subjects, and one particular instrument was labelled 1902, whereas I myself possess the original invoice of one purchased in 1899. Apart from this particular inaccuracy, 1902 was not covered by the present reign, a fact which the young stand attendant to whom I spoke doubted.

FOUNDATIONS OF WIRELESS

By A. L. M. SOWERBY, M.Sc.

Part XX.—Selectivity in the HF Amplifier

AFTER explaining why selectivity obtained by means of reaction is normally of the worst possible kind, the author goes on to deal with the question of the numerical evaluation of selectivity in "cascade" tuned circuits. The subject is treated from the dual points of view of high-note retention and immunity from interference.

WE have seen that, in theory, almost any degree of amplification can be obtained from a simple detector valve with the aid of reaction, but that, even apart from practical difficulties, this method of obtaining pre-detector amplification is unsatisfactory owing to the prodigious loss of high notes to which it gives rise. In consequence, we examined the possibility of obtaining the amplification we needed by using a valve before the detector. In doing so we found that provided we used a screened valve with an anode load consisting of a tuned circuit we could attain the results we required.

The question at once arises whether, in adding a second tuned circuit at the same time as the amplifying valve, we have not come back to our original difficulty of over-sharp tuning, with its consequent loss of high notes in the music eventually reaching the loud speaker.

The resonance curve of a tuned circuit can be measured by making use of a circuit on the lines of that of Fig. 105. Here an oscillator feeds energy into a small pick-up coil Lo which is connected in series with the inductance, inherent resistance, and capacity of the tuned circuit whose resonance curve it is desired to measure. By tuning the oscillator over a small range of frequencies which includes that to which the circuit is tuned, and observing by means of the valve voltmeter the voltage developed across the tuned circuit at each frequency, we obtain the data from which we can plot a curve of the type of those shown in Fig. 106.

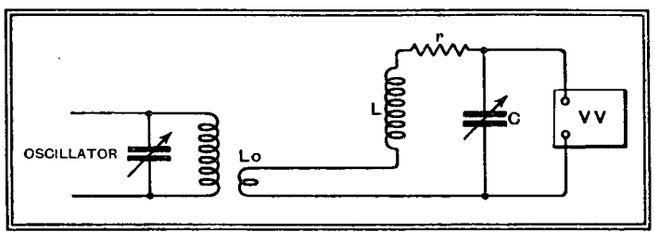


Fig. 105.—Method of measuring the resonance curve of a tuned circuit. The voltage across C is observed on the valve voltmeter VV for a number of different frequencies.

As we already know, the voltage is greatest at the frequency of resonance; that is, at the frequency for which the reactances of L and C are equal. For either higher or lower frequencies lower voltages are obtained, and the selectivity, or power of discrimination between neighbouring frequencies, shown by the circuit can be expressed by the ratio of the voltage at resonance to that at any other arbitrarily chosen frequency. It is quite clear that of the curves in Fig. 106 that at *a* refers to a more selective circuit than that at *b*.

Adjacent-channel Selectivity

It can be shown that, provided we restrict ourselves to considering the response of a tuned circuit to frequencies reasonably near to that at which it resonates, we can find the selectivity or plot the resonance curve of a tuned circuit from a knowledge of the ratio of the inductance L to the equivalent series resistance r of the complete circuit. If the voltage across the tuned circuit at resonance is Vo, and that across it for a frequency n cycles from resonance is Vn, then $Vo = Vn\sqrt{1+(4\pi n)^2\left(\frac{L}{r}\right)^2}$.

The complete square root, which we will hereafter abbreviate to s (for selectivity), tells us by how much we must multiply the voltage at n cycles from resonance to get the voltage at the resonant point. If $s=4$ at 10 kc/s off tune, the voltage at this frequency is one-quarter of that at resonance, and we speak of the circuit as being "four times down at 10 kc/s off tune."

The expression for s is rather a troublesome one to evaluate quickly for a rapid comparison of the selectivity of different circuits; actual values of s are therefore shown for L/r ratios up to 500 in the curves of Fig. 107. Separate curves are given for 5, 9, 18 and 27 kc/s off tune.

With the aid of these curves we are in a position to compare at once the selectivity of a reacting detector with that of a set containing a high-frequency amplifier, and therefore employing two tuned circuits. If we assume that at some particular frequency the ratio L/r of the tuned circuits in the amplifier is 10, then we see from Fig. 107 that at 5 kc/s off tune each circuit has its response reduced to 1/1.18 of that at resonance. For two tuned circuits the overall response will be the square of this, or 1/1.39; that is, the amplifier will pass 72 per cent. of the side-bands, representing high notes of frequency 5,000 cycles.

If the gain of the stage is assumed to be fifty times, then to get equal amplification by means of reaction we shall have to reduce r to one-fiftieth of its normal value, thereby increasing L/r to 500. Reference to Fig. 107 shows that with L/r raised to this value s becomes 30, making the response at 5 kc/s off tune one-thirtieth that at resonance. In this one tuned circuit side-bands are so cut that only some 3 per cent. of a 5,000-cycle note will reach the speaker. The loss at this frequency is thus some 35 times as great as when using the extra tuned circuit necessitated by the valve, although the amplification afforded is in each case the same.

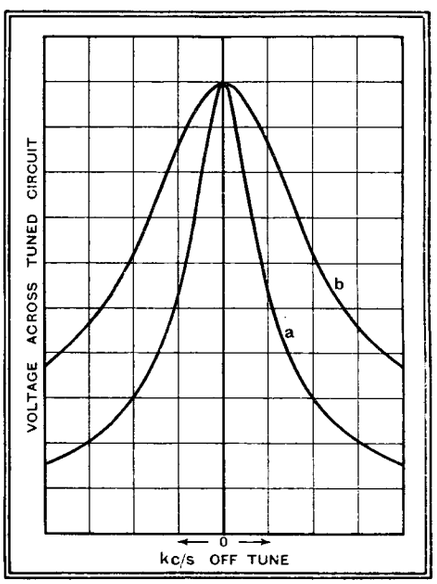


Fig. 106.—Typical resonance curves as derived from measurement; curve *a* corresponds to a selective, *b* to an unselective, tuned circuit.

To point the moral that reaction, if overdone, is ruinous to quality, it may be noted that twenty tuned circuits, each of $L/r=10$, are necessary to reduce the response at 5 kc/s off tune to that given by the single circuit with reaction enough to increase the signal-voltage across it fifty times. If each tuned circuit after the first were associated with an amplifying stage giving a gain of fifty times, the total amplification would be such that if by some miracle it could be applied to a halfpenny

Foundations of Wireless—

it would produce a sum of money so stupendous that one second's interest on it would relieve Great Britain of all taxation for a million million years. Which all goes to show that reaction is about the worst possible way of obtaining amplification.

Unfortunately for the set-designer there is another angle to this question of loss in high notes due to over-sharp tuning. While it is essential that we receive, with the desired carrier, the sidebands corresponding to the whole musical programme, including its highest notes, it is also essential that we exclude the carriers at least of the transmitters working on adjacent frequencies. We therefore require a resonance curve that has a flat top and steeply falling sides.

Some approximation to this can be obtained by using a large number of fairly flatly tuned circuits in cascade. Where a number of circuits are so used the overall s is found by raising the s-value for one circuit to the appropriate power—squaring for two circuits, cubing for three, and so on. To enable the reader to find for himself the behaviour of any series of tuned circuits in which he may be interested, Fig. 108 gives curves in a rather more general form than Fig. 107. In place of plotting s against L/r, and making a separate curve for each value of n, s is here plotted against the product $n \times L/r$. Curve 1 refers to one tuned circuit, curve 2 to two circuits, and so on up to a total of six circuits, all connected in cascade.

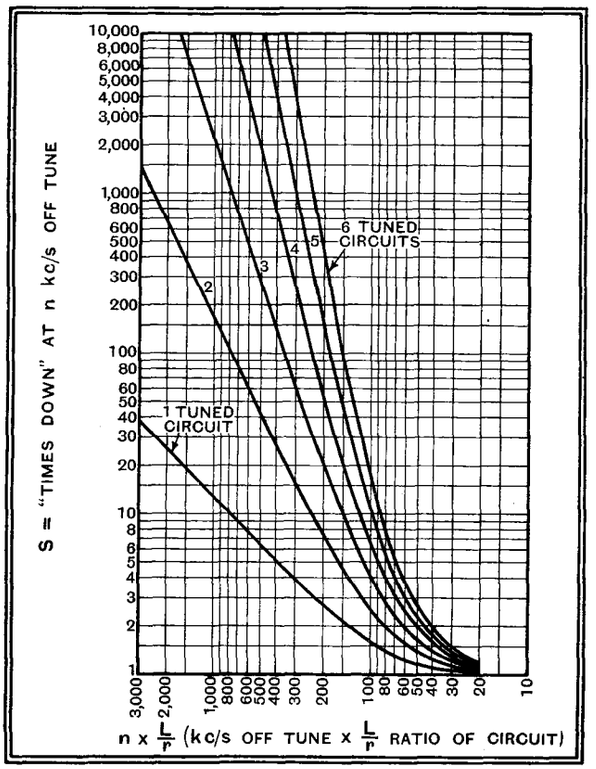


Fig. 108.—General data curves showing relationship between $n \times L/r$ and s for 1 to 6 tuned circuits in cascade.

To find, for example, "times down at 9 kc/s" for a series of circuits for each of which $L/r = 10$ we only have to multiply 10 by 9 to find $n \times L/r$, and look up the required figure on the curve corresponding to the number of tuned circuits for which the result is required. For one tuned circuit we find that $s = 1.5$, for two 2.25, for three 3.38, and so on. Alternatively, to find the requisite L/r to give 10 times down at 9 kc/s with four circuits, the value of $n \times L/r$ corresponding to $s = 10$ is read off from the curve for four circuits, and is found to be 119. The required L/r is then $119/9 = 13.2$.

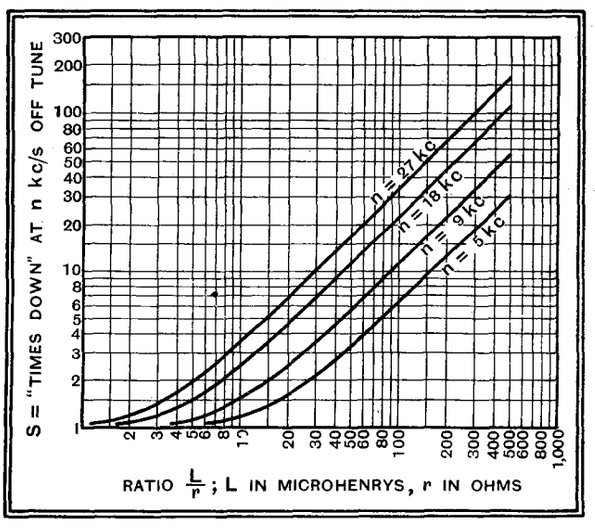


Fig. 107.—Showing relationship between L/r and s at 5, 9, 18, and 27 kc/s off tune.

Suppose, for example, we require to reduce the voltage of an interfering station 18 kc/s off tune to one-hundredth of the voltage it would have if exactly tuned in. As Fig. 107 shows, a single circuit to do this has $L/r = 450$, with which a 5 kc/s side-band will be 28 times down. If we used six tuned circuits the value of $n \times L/r$ required, as Fig. 108 shows, is 152, giving $L/r = 152/18 = 8.4$. At 5 kc/s off tune, $n \times L/r = 5 \times 8.4 = 42$, corresponding on Fig. 108 to 2.1 times down. Thus, for the same discrimination against an unwanted carrier 18 kc/s removed from that required, six circuits give over 12 times as great a response to a 5-kilocycle side-band.

To make this point clearer, Fig. 109 shows the complete resonance curve, derived from Fig. 108, for the two cases. The curves show very clearly that, although in both there is the same discrimination against a station 18 kc/s removed in frequency from that required, the single-tuned circuit can only provide this selectivity at the cost off lopping off the side-bands of the desired transmission to a very drastic extent. The more rounded curve for six tuned circuits, though by no means perfect, offends very much less in this respect.

Limitations of Reaction

To reach so high a value of L/r as 450 it would be necessary to use a good deal of reaction, so that these two curves may be taken as illustrating, from a different angle, the dangers of trying to make reaction do too much. We have seen already how it destroys quality when used as a substitute for true amplification; the curves of Fig. 109 emphasise that its use to provide selectivity that should be attained with additional tuned circuits brings just the same dire results in its train. These comments apply, of course, only to the excessive use of reaction; in off-setting detector damping, and perhaps providing,

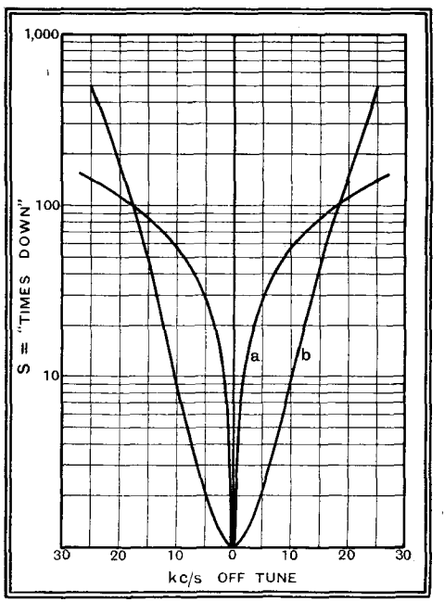


Fig. 109.—Resonance curves of one (a) and six (b) tuned circuits, chosen so as to give in each case 100 times reduction at 18 kc/s off tune. Note the enormous loss of side-bands in case a.

in addition, a *little* extra selectivity or sensitivity it is invaluable, especially in the less ambitious receiver.

We have taken, perhaps, an extreme case in comparing the resonance curves of one and six tuned circuits. A more practical comparison is that shown in the four curves of Fig. 110. Here we can see the differences in selectivity obtained by using one, two, three, or four tuned circuits, the L/r values in each case being chosen to give $1\frac{1}{2}$ times down at 5 kc/s—that is, a reduction of 5,000-cycle notes to two-thirds of their correct voltage, or 4/9ths their correct power (3.5 db. down). This

Foundations of Wireless—

corresponds to a barely noticeable loss at this frequency.

For one tuned circuit we require that $L/r = 18$, which is by no means an outrageous value. It is about that of an average tuned circuit at 400 metres. The selectivity is poor, a station 3 channels (27 kc/s) away being reduced only some 6 times. With two tuned circuits L/r for each comes out at 11, corresponding to that of an average tuned circuit at about 275 metres. A station 3 channels away is now reduced about 16 times. Adding a third circuit and making L/r now 8.8 still keeps the quality unchanged, but increases the selectivity to 32 times down at 27 kc/s. A fourth circuit increases this figure to 52.

Coils for the medium-wave band (200-550 metres) may roughly be taken as having values of L/r varying from about 5 or 6 at 200 metres up to about 20 for air-cored or 35 for iron-cored coils at 550 metres. Long-wave coils tuning from 1,000 to 2,000 metres generally run from 30 to 50 over the wave-band. Higher figures than this can easily be obtained on the latter band, but are hardly desirable owing to the severe loss of side-bands that they entail.

Consideration of these figures will make it clear that the ordinary set reduces the side-bands to a considerable extent, and yet suffers to some degree at least from insufficient selectivity. In spite of many attempts, the problem of making a satisfactory compromise between the conflicting claims of selectivity and quality is really not soluble in the case of the high-frequency amplifier. A nearer approach to the desired results can be attained in a superheterodyne receiver, in connection with which we shall have to return to the question.

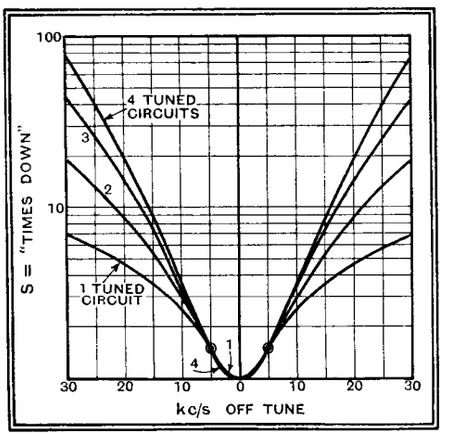


Fig. 110.—Overall resonance curves of one, two, three and four tuned circuits, in each case chosen to give "equal quality," represented by the same response to a 5-kc/s sideband.

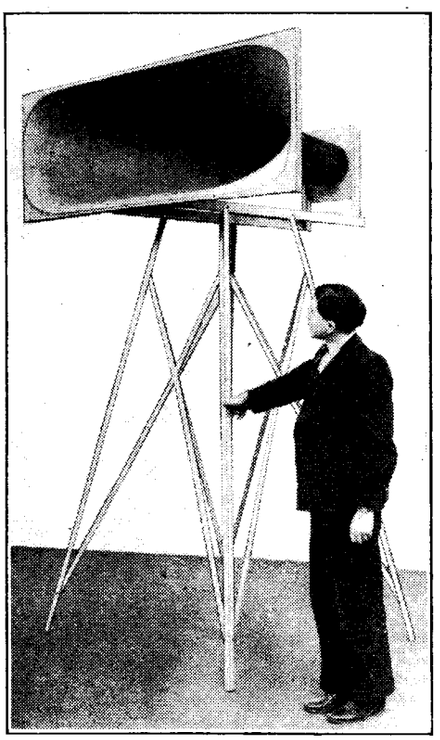
"Mono-Planar" Baffles

Economical Sound Distribution at Public Gatherings

THE problem of addressing open-air gatherings with the minimum outlay on equipment and expenditure of electrical power is largely one of conserving the acoustic energy generated and avoiding wasteful radiation in directions where it is not wanted.

With the object of reducing ground and sky losses, Scientific Supply Stores (Wireless), Ltd., 126, Newington Causeway, London, S.E.1, have designed and produced a series of "Mono-Planar" directional baffles with long rectangular apertures designed to spread the sound fan-wise in a horizontal plane. They are made to take standard moving-coil loud speaker units and are one-piece mouldings adequately waterproofed and mounted on a rigid framework. A collapsible angle-iron pylon, 7ft. in height is available as an extra. This is easily erected in a few minutes and when folded is only 4in. square, the cross-bracing members folding neatly inside the angles.

There can be no doubt that those responsible for public address installations at summer gatherings, large or small, will be quick to appreciate the advantages of these baffles. The flare in the model illustrated measures 26in. high and 74in. wide, while the depth from back to front is 54in. The price of the horn alone is £6 15s. and the collapsible pylon is 40s. extra. Although equivalent to a 4ft. horn in the area of the flare the "Mono-Planar" horn will pass easily through an ordinary doorway. It is also suitable for mobile equipments, as the shape lends itself for mounting on a van.



Scientific Supply Stores 64-cycle "Mono-Planar" direction baffle and collapsible pylon.

Random Radiations

By "DIALLIST"

Relays from Abroad

AT one time we used to have a good many programme relays from Continental studios, but of late these seem to have become rather fewer, which is a pity. It is true that we have "Five Hours Back" and the "American Half-hour" from the United States, but the kind of fare that American listeners enjoy does not appeal to all British listeners. Now comes the news that Eric Maschwitz, the B.B.C.'s Variety Director, is spending ten days in Budapest to investigate the practicability of suggestions for exchange programmes that have been made by the Budapest authorities. I am sure that programmes from Budapest would be most welcome, particularly during the summer months, when this station becomes difficult to receive until a rather late hour in the evening. The Budapest programmes are always attractive, one of their best points being the Cigany music for which the city is famous. The only real difficulty about the relays seems to be the cost of reserving telephone lines for the purpose. Budapest is about 900 miles from London as the crow flies, but a good deal farther as the telephone lines run.

America's Broadcast Programmes

In the last paragraph I suggested that programmes as broadcast from U.S.A. stations would not appeal to, by any means, all British listeners. The service given by the more important stations in that country is astonishing. They start the day at half-past six in the morning with music, and they continue with only the briefest of intervals from that time until two o'clock the next morning, when the programme concludes with selections by organ or orchestra. The American listener has thus 19½ hours of non-stop entertainment on weekdays and only 1½ hours less on Sundays.

And what kind of entertainment is it? The current week's programmes for one of their biggest stations are before me as I write. The first thing that strikes one is their extraordinary scrappiness; no item lasts for more than half an hour, and the great majority occupy but ten or fifteen minutes. There is a great deal of humour of the "wise-cracking" kind; frequent rations of crooners, blues singers and hot jazz bands, and a surprising amount of solo vocalists. There are many talks, and market reports and the like are given at intervals. But there is comparatively little good music, and plays of the kind that are popular here rarely figure in these programmes.

Another thing that would hardly suit us is the tendency for the same sponsored item to be given at the same hour every day for a week or longer. One realises, of course, that the artistes concerned are continually changing their matter, but even so I personally should find it rather boring to know that the same people were in the studio every day, say, at 6 o'clock, 6.15, 6.30, 7 o'clock and so on. This is not to decry Ameri-

Random Radiations—

can programmes; they are just what Americans want. But I am sure that those who clamour for our programmes to be reorganised on American lines would be the very first to grumble were any such change made.

Germany Goes One Better

One would have thought that half-past six in the morning was an early enough start for anybody, but the German authorities have determined that their listeners shall become even earlier birds than Americans. In future the main German stations are to start their day at 5 a.m. and to close down at 2 o'clock the following morning. They will thus be "on the air" for twenty-one hours out of the twenty-four. The object of the early morning broadcasts is stated to be to provide mental recreation for the manual workers, particularly peasants engaged in agriculture. A further series of concerts for factory workers is to take place between 6 and 8 a.m. It may be that the German agriculturists and the factory hands will respond to the invitation to switch on their sets at these unearthly hours, though few that I have come across in this country seem to have any burning desire to hear music before breakfast.

Myself, I feel that the provision of these enormous programmes is rather overdoing things. I am not at all sure that even in our own country we don't get too much broadcasting, and that we wouldn't be better off with smaller quantity and higher quality.

Changes in the West?

THE two worst areas in Great Britain for broadcast reception are probably North Wales and the West Country of Devon and Cornwall. The B.B.C. has realised this for some time; it appreciates also the desire of Wales for a station of its own whose programmes can be largely devoted to items that appeal mainly to inhabitants of the Principality. New stations are needed, but hitherto it has seemed that you could not have new stations with new wavelengths. The synchronising of the London, North and West Nationals has proved so satisfactory that it is more than likely that the B.B.C. will make further experiments of the kind with a view to releasing wavelengths for new stations. If experiments turn out well it is probable that the West Regional will become more and more of a Welsh station, and that Devon and Cornwall will be served by a medium-powered relay situated somewhere in the Plymouth district.

Another project is to improve reception of the Regional programmes in North Wales by the erection of a relay station near Bangor.

Beating the Book

VERILY the uses of wireless are legion! From Sydney, famous for its races, comes the information that the police have rounded up a gang who were merrily engaged in wirelessing the results of races to accomplices outside, the idea being, of course, for them to place starting-price bets to the discomfiture of the bookies. In one man's clothing was found a midget short-wave transmitter, a kind of harness supporting batteries and aerial.

Actually, this isn't the first time that attempts of this kind have been made. Not long ago a group of men in a certain Continental capital made use of the radio link for obtaining instant information, which was very much to their advantage, about dealings taking place within the stock exchange. Like the Sydney gang they were pretty quickly spotted and pulled in by the police.

The B.B.C.'s Future

LISTENERS may feel certain misgivings about the personnel of the committee which has been selected to consider the future of broadcasting and television after the expiring of the B.B.C.'s charter at the end of next year. The first thing that strikes one is that it contains an overwhelming political element. Lady Reading is the only women member, and nearly all of the others are either present or past Members of Parliament. The very last thing that we want in this country is any association of party politics or propaganda with broadcasting, and it is very much to be hoped that members of the committee will do their best to forget that they either are or have been politicians when they come to decide what is to happen to the B.B.C.

One can predict pretty confidently that they will recommend a renewal of the present charter, though possibly with certain minor alterations, at any rate so far as sound programmes are concerned. What will happen about the control of television is another question.

There are those who would like to see a separate authority for this new branch of broadcasting, but I think myself that it will probably remain in the hands of the B.B.C., since sound and vision are likely to become more and more closely linked together in the broadcasting entertainment for years to come.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

R/T and W/T

IN your issue of April 19th, under "Current Topics," is a paragraph headed "Radio on Lifeboats," giving the information that the fifty-six lifeboats of the *Normandie* will each carry wireless transmitting and receiving gear.

Curiously enough, "Diallist," under "Random Radiations," in the same issue, has a paragraph headed "Wireless or Radio?" but he makes no point of what is a useful distinction, i.e., "Wireless" should indicate W/T or wireless telegraphy, while "Radio" should mean R/T or radio telephony.

Being accustomed to the use of the terms in this sense, I was at first interested, and then disappointed, with the news of the W/T in the *Normandie's* lifeboats, expecting, from the heading of the paragraph, that they were to have R/T, which would have had far greater news value.

Orpington, Kent. A. G. BREMNER.

North National Transmitter

I WISH to draw your attention to the poor quality of transmissions from the above station after dark due to the syncronising with other Nationals and reduction in power.

I am situated within about twenty miles from the local transmitters, and despite the high signal strength the indirect wave from one of the other Nationals causes severe distortion at times, whilst the production of a deep intermittent "thudding" in the loud speaker is sometimes very disturbing.

I use *The Wireless World* Quality Amplifier adapted for purely local station reception, and the change has brought great disappointment to me, and doubtless many other lovers of quality. Though conditions are very inconsistent, sometimes good, sometimes very bad, the transmitter can no longer be relied upon to give us that quality of service which justifies the expenditure on high-quality receiving apparatus.

The advantages of a local station quality set here have, as it were, been halved, and to my mind the change marks a step of retrogression in the policy of the B.B.C.

Although my receiver employs two flatly tuned circuits only, the reception from Droitwich cannot compare with that previously obtained from the local mainly owing to the noticeable absence of high notes, and, were I to go to the trouble and expense of building the QA or Single-Span receiver, the atmospherics alone on long waves would still prevent Droitwich from becoming a true alternative.

The question one naturally wants to ask is: "Was this step on the part of the B.B.C. really necessary?" and, if so, do they not intend to reduce the interference and increase the reliable service area of the transmitter by the use of aerials sending less of their power up to old Heaviside or by some other means?

Knowing the keen interest taken by your most excellent journal in such matters, and the influence it has, I appeal to you to do all in your power to prevent the continuance of this back-sliding policy, which may do much to destroy the interests of the quality seeker and be a blow to the high standard you have set and have always striven to uphold.

Loud-speaker Response Curves

In conclusion, permit me to congratulate you on your loud-speaker response curves. These are what have been wanted for a long time, as, though they do not tell the whole story, they give what is surely the most important information where high-quality reproduction is concerned.

At any rate, half a loaf is better than nothing, which has previously been the case with the vast majority of people who have simply no opportunities of hearing various high-grade speakers when wishing to purchase one. Your journal is the only source of reliable information in this matter.

It is with eagerness, therefore, that I await the next instalment of these curves, which is surely overdue. Or is it that many speaker manufacturers are reluctant to submit their products for your examination and publication? At any rate, I was rather surprised at some omissions from your first batch, and hope they will be included in your next. It will be interesting to compare a curve taken by your staff and that published by the makers in their technical booklet.

Wishing your journal the success and prosperity it deserves.

Accrington, Lancs. W. IRONFIELD.

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an aerial power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Kaunas (Lithuania)	155	.....	1935	7
Brazov (Romania)	160	.....	1875	20
Huizen (Holland). (*Until* 3.40 *p.m.*)	160	.....	1875	7
Kootwijk (Holland) (*Transmits Hilversum programme after* 3.40 *p.m.*)	160	.....	1875	50
Lahti (Finland)	166	.....	1807	40
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	174	.....	1724	500
Paris (Radio Paris) (France)	182	.....	1648	80
Istanbul (Turkey)	187.5	.....	1600	5
Berlin (Deutschlandsender Zeesen) (Germany)	191	.....	1571	60
Droitwich	200	.....	1500	150
Minsk, RW10 (U.S.S.R.)	208	.....	1442	35
Reykjavik (Iceland)	208	.....	1442	16
Motala (Sweden). (*Relays Stockholm*)	216	.....	1389	30
Novosibirsk, RW76 (U.S.S.R.)	217.5	.....	1379	100
Warsaw, No. 1 (Raszyn) (Poland)	224	.....	1339	120
Ankara (Turkey)	230	.....	1304	7
Luxembourg	230	.....	1304	150
Kharkov, RW20 (U.S.S.R.)	232	.....	1293	20
Kalundborg (Denmark)	238	.....	1261	60
Leningrad, RW53 (Kolpino) (U.S.S.R.)	245	.....	1224	100
Tashkent, RW11 (U.S.S.R.)	256.4	.....	1170	25
Oslo (Norway)	260	.....	1154	60
Moscow, No. 2, RW49 (Shchelkovo) (U.S.S.R.)	271	.....	1107	100
Tiflis, RW7 (U.S.S.R.)	280	.....	1071.4	35
Rostov-on-Don, RW12 (U.S.S.R.)	355	.....	845	20
Sverdlovsk, RW5 (U.S.S.R.)	375	.....	800	50
Geneva (Switzerland). (*Relays Sottens*)	401	.....	748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401	.....	748	100
Voroneje, RW25 (U.S.S.R.)	413.5	.....	726	10
Oulu (Finland)	431	.....	696	1.2
Ufa, RW22 (U.S.S.R.)	436	.....	688	10
Hamar (Norway) (*Relays Oslo*)	519	.....	578	0.7
Innsbruck (Austria). (*Relays Vienna*)	519	.....	578	1
Ljubljana (Yugoslavia)	527	.....	569.3	5
Viipuri (Finland)	527	.....	569.3	10
Bolzano (Italy)	536	.....	559.7	1
Wilno (Poland)	536	.....	559.7	16
Budapest, No. 1 (Hungary)	546	.....	549.5	120
Beromünster (Switzerland)	556	.....	539.6	100
Athlone (Irish Free State)	565	.....	531	60
Palermo (Italy)	565	.....	531	4
Stuttgart (Mühlacker) (Germany)	574	.....	522.6	100
Grenoble, P.T.T. (France)	583	.....	514.6	15
Riga (Latvia)	583	.....	514.6	15
Vienna (Bisamberg) (Austria)	592	.....	506.8	100
Rabat (Radio Maroc) (Morocco)	601	.....	499.2	25
Sundsvall (Sweden). (*Relays Stockholm*)	601	.....	499.2	10
Florence (Italy). (*Relays Milan*)	610	.....	491.8	20
Cairo (Abu Zabal) (Egypt)	620	.....	483.9	20
Brussels, No. 1 (Belgium). (*French Programme*)	620	.....	483.9	15
Lisbon (Bacarena) (Portugal)	629	.....	476.9	20
Tröndelag (Norway)	629	.....	476.9	20
Prague, No. 1 (Czechoslovakia)	638	.....	470.2	120
Lyons, P.T.T. (La Doua) (France)	648	.....	463	15
Cologne (Langenberg) (Germany)	658	.....	455.9	100
North Regional (Slaithwaite)	668	.....	449.1	50
Sottens (Radio Suisse Romande) (Switzerland)	677	.....	443.1	25
Belgrade (Yugoslavia)	686	.....	437.3	2.5
Paris, P.T.T. (Ecole Supérieure) (France)	695	.....	431.7	7
Stockholm (Sweden)	704	.....	426.1	55
Rome, No. 1 (Italy)	713	.....	420.8	50
Kiev, RW9 (U.S.S.R.)	722	.....	415.5	36
Tallinn (Esthonia)	731	.....	410.4	20
Madrid, EAJ2 (Radio España) (Spain)	731	.....	410.4	3
Munich (Germany)	740	.....	405.4	100
Marseilles, P.T.T. (France)	749	.....	400.5	5
Katowice (Poland)	758	.....	395.8	12
Scottish Regional (Falkirk)	767	.....	391.1	50
Toulouse, P.T.T. (France)	776	.....	386.6	2
Leipzig (Germany)	785	.....	382.2	120
Barcelona, EAJ1 (Spain)	795	.....	377.4	5
Lwow (Poland)	795	.....	377.4	16
West Regional (Washford Cross)	804	.....	373.1	50
Milan (Italy)	814	.....	368.6	50
Bucharest (Romania)	823	.....	364.5	12
Moscow, No. 4, RW39 (Stalina) (U.S.S.R.)	832	.....	360.6	100
Berlin (Funkstunde Tegel) (Germany)	841	.....	356.7	100
Bergen (Norway)	850	.....	352.9	1
Sofia (Bulgaria)	850	.....	352.9	1
Valencia (Spain)	850	.....	352.9	1.5
Simferopol, RW52 (U.S.S.R.)	859	.....	349.2	10
Strasbourg, P.T.T. (France)	859	.....	349.2	35
Poznan (Poland)	868	.....	345.6	16
London Regional (Brookmans Park)	877	.....	342.1	50
Graz (Austria). (*Relays Vienna*)	886	.....	338.6	7
Helsinki (Finland)	895	.....	335.2	10
Hamburg (Germany)	904	.....	331.9	100
Toulouse (Radio Toulouse) (France)	913	.....	328.6	60
Limoges, P.T.T. (France)	913	.....	328.6	0.5
Brno (Czechoslovakia)	922	.....	325.4	32
Brussels, No. 2 (Belgium). (*Flemish Prog'mme*)	932	.....	321.9	15
Algiers, P.T.T. (Radio Alger) (Algeria)	941	.....	318.8	12
Göteborg (Sweden). (*Relays Stockholm*)	941	.....	318.8	10
Breslau (Germany)	950	.....	315.8	100
Paris (Poste Parisien) (France)	959	.....	312.8	60
Belfast	977	.....	307.1	1
Genoa (Italy). (*Relays Milan*)	986	.....	304.3	10
Hilversum (Holland). (7 *kW.* till 6.40 p.m.)	995	.....	301.5	20
Bratislava (Czechoslovakia)	1004	.....	298.8	13.5
Midland Regional (Droitwich)	1013	.....	296.2	50
Barcelona, EAJ15 (Radio Asociación) (Spain)	1022	.....	293.5	3
Cracow (Poland)	1022	.....	293.5	2
Königsberg (Heilsberg Ermland) (Germany)	1031	.....	291	17
Parede (Radio Club Português) (Portugal)	1031	.....	291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040	.....	288.5	10
Rennes, P.T.T. (France)	1040	.....	288.5	40
Scottish National (Falkirk)	1050	.....	285.7	50
Bari (Italy)	1059	.....	283.3	20
Tiraspol, RW57 (U.S.S.R.)	1068	.....	280.9	4
Bordeaux, P.T.T. (Lafayette) (France)	1077	.....	278.6	30
Zagreb (Yugoslavia)	1086	.....	276.2	0.7
Falun (Sweden)	1086	.....	276.2	2
Madrid, EAJ7 (Union Radio) (Spain)	1095	.....	274	7
Madona (Latvia)	1104	.....	271.7	50
Naples (Italy). (*Relays Rome*)	1104	.....	271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113	.....	269.5	11.2
Fécamp (Radio Normandie) (France)	1113	.....	269.5	10
Alexandria (Egypt)	1122	.....	267.4	0.25
Newcastle	1122	.....	267.4	1
Nyiregyhaza (Hungary)	1122	.....	267.4	6.2
Hörby (Sweden). (*Relays Stockholm*)	1131	.....	265.3	10
Turin, No. 1 (Italy). (*Relays Milan*)	1140	.....	263.2	7
London National (Brookmans Park)	1149	.....	261.1	20
North National (Slaithwaite)	1149	.....	261.1	20
West National (Washford Cross)	1149	.....	261.1	20
Kosice (Czechoslovakia). (*Relays Prague*)	1158	.....	259.1	2.6
Monte Ceneri (Switzerland)	1167	.....	257.1	15
Copenhagen (Denmark). (*Relays Kalundborg*)	1176	.....	255.1	10
Kharkov, No. 2, RW4 (U.S.S.R.)	1185	.....	253.2	10
Frankfurt (Germany)	1195	.....	251	17
Prague, No. 2 (Czechoslovakia)	1204	.....	249.2	5
Lille, P.T.T. (France)	1213	.....	247.3	5
Trieste (Italy)	1222	.....	245.5	10
Gleiwitz (Germany). (*Relays Breslau*)	1231	.....	243.7	5
Cork (Irish Free State) (*Relays Athlone*)	1240	.....	241.9	1
Juan-les-Pins (Radio Côte d'Azur) (France)	1249	.....	240.2	2
Kuldiga (Latvia)	1258	.....	238.5	10
Rome, No. 3 (Italy)	1258	.....	238.5	1
San Sebastian (Spain)	1258	.....	238.5	3
Nürnberg and Augsburg (Germany) (*Relay Munich*)	1267	.....	236.8	2
Christiansand and Stavanger (Norway)	1276	.....	235.1	0.5
Dresden (Germany) (*Relays Leipzig*)	1285	.....	233.5	1.5
Aberdeen	1285	.....	233.5	1
Austrian Relay Stations	1294	.....	231.8	0.5
Danzig. (*Relays Königsberg*)	1303	.....	230.2	0.5
Swedish Relay Stations	1312	.....	228.7	1.25
Budapest, No. 2 (Hungary)	1321	.....	227.1	1.25
German Relay Stations	1330	.....	225.6	1.5
Montpellier, P.T.T. (France)	1339	.....	224	5
Lodz (Poland)	1339	.....	224	1.7
Dublin (Irish Free State) (*Relays Athlone*)	1348	.....	222.6	0.5
Milan, No. 2 (Italy) (*Relays Rome*)	1348	.....	222.6	4
Turin, No. 2 (Italy). (*Relays Rome*)	1357	.....	221.1	0.2
Basle and Berne (Switzerland)	1375	.....	218.2	0.5
Warsaw, No. 2 (Poland)	1384	.....	216.8	2
Lyons (Radio Lyons) (France)	1393	.....	215.4	5
Tampere (Finland)	1420	.....	211.3	0.7
Paris, (Radio LL) (France)	1424	.....	210.7	0.8
Béziers (France)	1429	.....	209.9	1.5
Miskolc (Hungary)	1438	.....	208.6	1.25
Paris (Eiffel Tower) (France)	1456	.....	206	5
Pecs (Hungary)	1465	.....	204.8	1.25
Bournemouth	1474	.....	203.5	1
Plymouth	1474	.....	203.5	0.3
International Common Wave	1492	.....	201.1	0.2
International Common Wave	1500	.....	200	0.25
Liepàja (Latvia)	1737	.....	173	0.1

NOTE. Since the publication of the previous list alterations have been made to the particulars of the following stations: Eiffel Tower, Fecamp.

SHORT-WAVE STATIONS OF THE WORLD

(N.B.—Times of Transmission given in parentheses are approximate only and represent G.M.T.)

Metres.	kc/s.	Call Sign.	Station.	Tuning Positions.
70.2	4,273	RV15	Kharbarovsk (U.S.S.R.). (*Daily* 06.00 *to* 14.00.)	
58.31	5,145	OK1MPT	Prague (Czechoslovakia). (*Experimental*)	
55.56	5,400	HAT	Budapest (Hungary). (*Mon.* 01.00 *to* 02.00.)	
52.7	5,692	FIQA	Antananarivo (Madagascar). (*Daily ex. Sun.* 08.00 *to* 08.45, 15.00 *to* 16.00, *Sat.* 17.30 *to* 19.00, *Sun.* 07.30 *to* 08.00.)	
50.26	5,969	HVJ	Vatican City. (*Daily* 19.00 *to* 19.15, *Sun.* 10.00 *also.*)	
50.0	6,000	—	Bucharest (Romania)	
50.0	6,000	RW59	Moscow (U.S.S.R.). (*Relays No.* 1 *Stn.*) (*Daily* 20.00 *to* 23.00.)	
49.96	6,005	VE9DN	Montreal (Canada). (*Daily* 04.30 *to* 05.00)	
49.96	6,005	HJ3ABH	Bogotá (Colombia)	
49.85	6,018	ZHI	Singapore (Malaya). (*Mon., Wed., Thurs.* 23.00 *to* 01.30, *Sun.* 03.40 *to* 05.10.)	
49.83	6,020	DJC	Zeesen (Germany). (*Daily* 22.30 *to* 03.30, 17.00 *to* 21.30.)	
49.67	6,040	W1XAL	Boston, Mass. (U.S.A.). (*Sun.* 22.00 *to* 24.00, *Wed., Fri.* 00.30 *to* 01.45.)	
49.67	6,040	YDB	Sourabaya (Java). (*Daily* 03.30 *to* 06.30)	
49.59	6,050	GSA	Empire Broadcasting	
49.5	6,060	W8XAL	Cincinnati, Ohio (U.S.A.). (*Daily* 12.00 *to* 01.00, 04.00 *to* 06.00.)	
49.5	6,060	W3XAU	Philadelphia, Pa. (U.S.A.) (*Relays WCAU.*) (*Daily* 01.00 *to* 04.00.)	
49.5	6,060	VQ7LO	Nairobi (Kenya Colony). (*Daily* 16.00 *to* 19.00, *Sat. to* 20.00, *Mon., Wed., Fri.* 10.45 *to* 11.15 *also, Tues.* 08.00 *to* 09.00 *also, Thurs.* 13.00 *to* 14.00 *also, Sun.* 17.45 *to* 19.00 *also.*)	
49.5	6,060	OXY	Skamlebaek (Denmark). (*Relays Kalundborg.*) (*Daily* 18.00 *to* 24.00, *Sun.* 16.00 *also.*)	
49.43	6,069	VE9CS	Vancouver, B.C. (Canada). (*Sat.* 04.30 *to* 05.45, *Sun.* 16.00 *to* 04.00.)	
49.4	6,072	ZHJ	Penang (Malaya). (*Relays Empire Broadcasting.*)	
49.4	6,072	OER2	Vienna Experimental. (*Daily* 14.00 *to* 22.00.)	
49.34	6,080	W9XAA	Chicago, Ill. (U.S.A.). (*Relays WCLF.*) (*Sun.* 19.00 *to* 20.30.)	
49.3	6,085	2RO	Rome (Italy). (*Mon., Wed., Fri.* 23.00 *to* 00.30.)	
49.26	6,090	VE9BJ	St. John (N.B.). (*Daily* 00.00 *to* 01.30)...	
49.26	6,090	VE9GW	Bowmanville, Ont. (Canada). (*Mon., Tues., Wed.* 20.00 *to* 05.00, *Thurs., Fri., Sat.* 12.00 *to* 05.00, *Sun.* 18.00 *to* 02.00.)	
49.2	6,097	ZTJ	Johannesburg (S. Africa). (*Daily ex. Sun.* 04.30 *to* 05.30, 08.30 *to* 12.00, 14.00 *to* 20.00 (*Sat. to* 21.45), *Sun.* 13.00 *to* 15.15, 17.30 *to* 20.00.)	
49.18	6,100	W3XAL	Bound Brook, N.Y. (U.S.A.). (*Relays WJZ.*) (*Mon., Wed., Sat.* 22.00 *to* 23.00, *Sat.* 05.00 *to* 06.00 *also.*)	
49.18	6,100	W9XF	Chicago, Ill. (U.S.A.). (*Daily ex. Mon., Wed., Sun.* 21.00 *to* 07.00.)	
49.1	6,110	VUC	Calcutta (India). (*Daily* 07.06 *to* 08.06 *irregular* 13.06 *to* 16.36, *Sat. from* 12.36. *Sun.* 04.36 *to* 07.36, *irregular* 12.36 *to* 03.36.	
49.1	6,110	VE9HX	Halifax N.S. (*Daily* 14.00 *to* 16.30, 21.00 *to* 04.00.)	
49.1	6,110	GSL	Empire Broadcasting	
49.02	6,120	YDA	Bandoeng (Java). (*Daily* 10.30 *to* 15.00)	
49.02	6,120	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 23.00 *to* 04.00.)	
48.92	6,132	ZGE	Kuala Lumpur (Malaya). (*Sun., Tues. Fri.* 11.40 *to* 13.40.)	
48.86	6,140	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 21.30 *to* 06.00.)	
48.78	6,150	CJRO	Winnipeg (Canada). (*Daily* 00.00 *to* 05.00, *Sat.* 21.00 *to* 06.00 *also, Sun.* 22.00 *to* 03.30.)	
48.4	6,198	CT1GO	Parede (Portugal). (*Daily ex. Tues.* 00.20 *to* 01.30, *Sun.* 16.30 *to* 18.00 *also.*)	
48.69	6,425	W3XL	Bound Brook, N.J. (U.S.A.). (*Experimental*)	
45.38	6,610	RW72	Moscow (U.S.S.R.). (*Relays Stalin Stn.*)...	
38.48	7,797	HBP	Radio Nations, Prangins (Switzerland). (*Sat.* 22.30 *to* 23.15.)	
37.33	8,035	CNR	Rabat (Morocco). (*Sun.* 20.00 *to* 22.30)...	
31.58	9,500	PRF5	Rio de Janeiro (Brazil). (*Daily* 22.30 *to* 23.15.)	
31.55	9,510	GSB	Empire Broadcasting	
31.54	9,518	VK3ME	Melbourne (Australia). (*Wed.* 10.00 *to* 11.30, *Sat.* 10.00 *to* 12.00.)	
31.48	9,530	W2XAF	Schenectady, N.Y. (U.S.A.). (*Relays WGY.*) (*Daily* 23.30 *to* 04.00, *Sat.* 19.00 *to* 22.00 *also.*)	
31.45	9,540	LKJ1	Jelöy (Norway). (*Relays Oslo.*) (*Daily* 10.00 to 13.00.)	
31.45	9,540	DJN	Zeesen (Germany). (*Daily* 08.45 *to* 12.15, 13.00 *to* 16.30, 22.15 *to* 03.30.)	
31.38	9,560	DJA	Zeesen (Germany). (*Daily* 13.00 *to* 16.30, 22.15 *to* 02.00.)	
31.36	9,565	VUB	Bombay (India). (*Sun.* 13.30 *to* 15.30, *Wed., Thurs., Sat.* 16.30 *to* 17.30, *irregular Mon.*).	
31.35	9,570	W1XK	Springfield, Mass. (U.S.A.). (*Relays WBZ.*) (*Daily* 12.00 *to* 06.00.)	
31.32	9,580	GSC	Empire Broadcasting	
31.32	9,580	VK3LR	Lindhurst (Australia). (*Daily ex. Sun.* 08.15 *to* 12.30.)	
31.28	9,590	W3XAU	Philadelphia, Pa. (U.S.A.). (*Relays WCAU.*) (*Daily* 17.00 *to* 24.00.)	
31.28	9,590	VK2ME	Sydney (Australia). (*Sun.* 06.00 *to* 08.00, 10.00 *to* 14.00, 14.30 *to* 16.30.)	
31.27	9,595	HBL	Radio Nations, Prangins (Switzerland). (*Sat.* 22.30 *to* 23.15.)	
31.25	9,600	CT1AA	Lisbon (Portugal). (*Tues., Thurs., Sat.* 21.30 *to* 24.00.)	
31.13	9,637	2RO	Rome (Italy). (*Tues., Thurs., Sat.* 00.45 *to* 02.15).	
31.0	9,677	CT1CT	Lisbon (Portugal). (*Thurs.* 21.00 *to* 23.00, *Sun.* 12.00 *to* 14.00.)	
30.43	9,860	EAQ	Madrid (Spain). (*Daily* 22.15 *to* 00.30, *Sat.* 18.00 *to* 20.00 *also.*)	
29.04	10,330	ORK	Ruysselede (Belgium). (*Daily* 18.30 *to* 20.30.)	
28.98	10,350	LSX	Buenos Aires (Argentina). (*Daily* 20.00 *to* 21.00.)	
25.6	11,720	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. E-W.*) *Daily* 00.00 *to* 03.00, 04.00 *to* 06.00.)	
25.6	11,720	CJRX	Winnipeg (Canada). (*Daily* 00.00 *to* 05.00, *Sat.* 21.00 *to* 06.00 *also. Sun.* 22.00 *to* 03.30 *also.*)	
25.57	11,730	PHI	Eindhoven (Holland). (*Daily ex. Tues., Wed.* 13.00 *to* 15.30 (*Sun. Sat. to* 16.30.)	
25.53	11,750	GSD	Empire Broadcasting	
25.49	11,770	DJD	Zeesen (Germany). (*Daily* 17.00 *to* 21.30)	
25.45	11,790	W1XAL	Boston, Mass. (U.S.A.). (*Daily* 23.00 *to* 00.30.)	
25.4	11,810	2RO	Rome (Italy) (*Mon., Wed., Fri.*, 23.00) ...	
25.36	11,830	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 20.00 *to* 22.00.)	
25.29	11,860	GSE	Empire Broadcasting	
25.27	11,870	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 21.30 *to* 03.00.)	
25.23	11,880	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. N-S.*) (*Daily* 16.15 *to* 19.15, 20.00 *to* 23.00.)	
25.0	12,000	RW59	Moscow (U.S.S.R.). (*Relays No.* 2 *Stn.*) (*Sun.* 03.00 *to* 04.00, 11.00 *to* 12.00, 15.00 *to* 16.00.)	
24.83	12,082	CT1CT	Lisbon (Portugal). (*Sun.* 14.00 *to* 16.00, *Thurs.* 20.00 *to* 21.00.)	
24.2	12,396	CT1GO	Parede (Portugal). (*Sun.* 15.00 *to* 16.30, *Tues., Thurs., Fri.* 18.00 *to* 19.15.)	
23.39	12,830	CNR	Rabat (Morocco). (*Sun.* 12.30 *to* 14.00)...	
19.84	15,123	HVJ	Vatican City. (*Daily* 10.00, 15.30 *to* 15.45)	
19.82	15,140	GSF	Empire Broadcasting	
19.74	15,200	DJB	Zeesen (Germany). (*Daily* 08.45 *to* 12.15)	
19.72	15,210	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 13.00 *to* 21.15.)	
19.71	15,220	PCJ	Eindhoven (Holland). (*Experimental*) ...	
19.68	15,243	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. E.W.*) (*Daily* 12.00 *to* 16.00.)	
19.67	15,250	W1XAL	Boston, Mass. (U.S.A.). (*Daily* 15.50 *to* 18.30.)	
19.66	15,260	GSI	Empire Broadcasting	
19.64	15,270	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 16.00 *to* 18.00.)	
19.56	15,330	W2XAD	Schenectady, N.Y. (U.S.A.). (*Daily* 19.30 *to* 20.30.)	
19.52	15,370	HAS3	Budapest (Hungary). (*Sun.* 13.00 *to* 14.00.)	
17.33	17,310	W3XL	Bound Brook, N.J. (U.S.A.). (*Daily* 16.00 *to* 22.00.)	
16.89	17,760	DJE	Zeesen (Germany) (*Daily* 13.00 *to* 16.30.)	
16.87	17,780	W3XAL	Bound Brook, N.J. (U.S.A.). (*Relays WJZ.*) (*Daily except Sun.* 14.00 *to* 15.00, *Tues., Thurs., Fri.* 20.00 *to* 21.00 *also.*)	
16.86	17,790	GSG	Empire Broadcasting	
13.97	21,470	GSH	Empire Broadcasting	
13.93	21,530	GSJ	Empire Broadcasting	
13.92	21,540	W8XK	Pittsburg, Pa. (U.S.A.). (*Daily* 12.00 *to* 14.00.)	

THE RADIO INDUSTRY

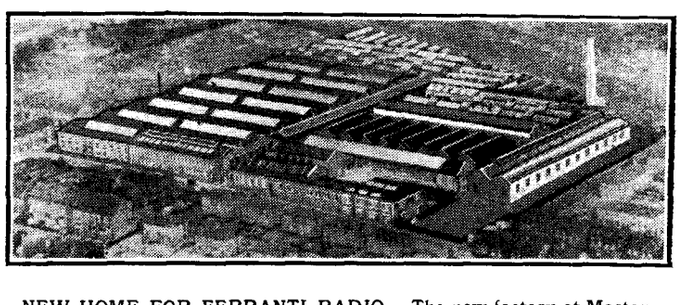
EVERETT, EDGCUMBE AND CO., LTD., of Colindale Works, Hendon, London, N.W.9, have just issued a new edition of the booklet "Modern Service Methods," which has been entirely rewritten and brought up to date; a copy is given with every Radiolab Set Analyser and Valve Tester (to which the booklet particularly relates), or it can be obtained direct from the firm for 7½d., post free.

◇ ◇ ◇ ◇

Unit Radio, whose new address is 347, City Road, London, E.C.1 (Tel.: Clerkenwell 5340), has issued a leaflet describing two short-wave converters. One of these is an AC/DC mains model, and the other is for battery feed.

◇ ◇ ◇ ◇

Halcyon Radio, Ltd., of Sterling Works, Dagenham, Essex, has just issued a pamphlet describing the various Halcyon Universal models. In it are printed published test reports, including one which appeared in *The Wireless World*.



NEW HOME FOR FERRANTI RADIO.—The new factory at Moston, where all Ferranti radio activities are now concentrated. In future, all communications regarding radio matters should be addressed to Ferranti, Ltd., Radio Works, Moston, Manchester, 10.

The Wireless World

THE PRACTICAL RADIO JOURNAL
25th Year of Publication

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	457
Modulated Test Oscillator	458
Practical Volume Expansion	461
Current Topics	463
Wireless and the Atmosphere	464
An Acoustic Spectroscope	467
Short Waves and the Amateur	469
Hints and Tips	471
Listeners' Guide for the Week	472
Climax Model 534 Reviewed	474
New Apparatus Reviewed	476
Broadcast Brevities	477
Foundations of Wireless XXI	478

EDITORIAL COMMENT

The B.B.C. Inquiry

"To consider the constitution, control and finance of the Broadcasting Service in this country and advise generally on the conditions under which the service, including broadcasting to the Empire, television broadcasting, and the system of wireless exchanges, should be conducted after December 31, 1936."

THESE are the terms of reference of the Committee appointed by the Postmaster-General which met for the first time last week.

The idea of a Committee of Inquiry is very generally associated with a necessity for rectifying mistakes or adjusting grievances, so that the first impression created by the announcement that the Government have set up a Committee of Inquiry to consider the future of Broadcasting might be that the British Broadcasting Corporation were under a cloud and that their actions during the present term of their Charter, which expires at the end of 1936, were in question.

Nothing could be further from the truth, and we anticipate that the Committee will not only recommend the continuance of broadcasting on the present lines, but will endorse wholeheartedly the general policy which has been followed hitherto.

The Committee will, it seems, have to act quite largely in the capacity of a consulting body to whom the B.B.C. can bring some of their own problems to be solved. The problems of the B.B.C., some of which amount almost to grievances to-day, probably outbalance any criticisms of the B.B.C. from outside. In particular, there is the question of finance. It has never been a secret of the B.B.C. that the task which has been entrusted to them has tended all the time to strain the financial resources of their income. Of the gross receipts from licences during 1934, less than half of the amount was made available to the B.B.C. for broadcasting purposes, only 4s. 9d. of the licence fee being allotted to them as their share.

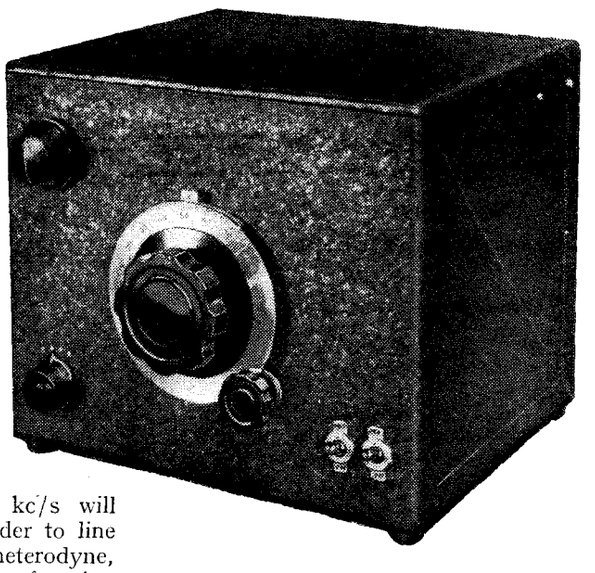
The expenditure of the Corporation must inevitably grow with the expansion of their undertakings. Empire broadcasting could be extended and developed to become a far more important service than it is to-day if its progress were not being hindered through lack of funds.

The service of television about to be launched will necessitate a heavy capital expenditure before it can provide entertainment over the whole country, and the cost of programmes, too, will prove a heavy item. As we have frequently pointed out, the success of television on the technical side does not cause us much anxiety, but the programmes must be first-rate and sufficiently attractive to compel the interest of the public, or otherwise television will not succeed. It would be little short of a tragedy if British ingenuity, and the heavy expenditure which has been incurred in technical development of television in this country, should fail to bring reward because of insufficient funds in the hands of the B.B.C. to enable them to provide attractive programme material.

Our own interpretation, therefore, of the task before the Committee of Inquiry is that they should suggest solutions to the problems of the B.B.C. which are beyond their scope to solve domestically and, in particular, to discover what further proportion of the licence fees should go to the Corporation to meet their increasing needs, and finally to recommend the renewal of the Corporation's Charter with, in all probability, only minor, if any, modifications.

Modulated Test Oscillator

Wide Range Oscillator for Set Testing and Adjusting Receivers



THE initial adjustments of ganging and trimming a receiver are greatly facilitated by a local source of modulated signals which can be adjusted at will to any frequency and any strength within wide limits. The oscillator described in this article meets all such set testing requirements and if carefully calibrated may also be used as a reliable wavemeter.

TO both the serious experimenter and the service man a calibrated oscillator is an indispensable part of his equipment. In its essentials it consists of an HF oscillator which can be tuned to any signal or intermediate frequency likely to be needed and which can be modulated by a low-frequency oscillator when required. An oscillator of this nature can take many forms, ranging from a simple assembly of gear usually to be found in the junk box to an elaborate outfit capable of delivering a known output of any desired value modulated to any required degree at any frequency. The former is usually incapable of being calibrated to any degree of precision, and the latter is a laboratory standard-signal generator which, although an indispensable tool to the set designer, is unnecessarily complex and accurate for the adjustment and general servicing of receivers.

In order to adjust the ganging of a modern receiver, a source of HF energy of known frequency is needed and a calibrated oscillator covering the bands of 150-400 kc/s and 550-1,500 kc/s will meet all requirements. In order to line up the IF circuits of a superheterodyne, however, the oscillator must also function at this frequency. The intermediate frequencies in commonest use to-day are 110 kc/s and 126 kc/s, but there are signs that frequencies of 450 kc/s and 465 kc/s will soon become widespread, and, of course, all single-span receivers employ 1,600 kc/s. It can be seen, therefore, that to meet all requirements the oscillator must be capable of functioning on any frequency between some 100 kc/s and 1,700 kc/s.

It is not possible to cover such a wide range with a single coil and variable condenser, and even in apparatus of this nature plug-in coils are as much a nuisance as in a broadcast receiver, for it is often necessary to change from one end of the frequency range to the other. There are two ways of avoiding the use of plug-in coils. The first is one which is often employed where simplicity of construction, but not of operation, is important. A single coil and variable condenser are used and a certain range of perhaps 100-200 kc/s is covered by the fundamental component of the oscillator output. The second range of 200-400 kc/s is covered by the second harmonic, a third of 300-600 kc/s by the third, and so on. The disadvantage of this system is that all ranges are present simultaneously, and if the oscillator be set at, say, 150 kc/s, the output is at 150 kc/s, 300 kc/s, 450 kc/s, 600 kc/s, 750 kc/s, 900 kc/s, 1,050 kc/s, 1,200 kc/s, 1,350 kc/s, and 1,500 kc/s, taking harmonics up to the tenth. Whichever of these frequencies be required, the oscillator dial setting is the same, so that it is often quite troublesome to determine which harmonic is being used, and therefore the frequency to which the receiver is responding. Moreover, the harmonics progressively weaken as their degree is raised, so that the output at high frequencies may not be adequate.

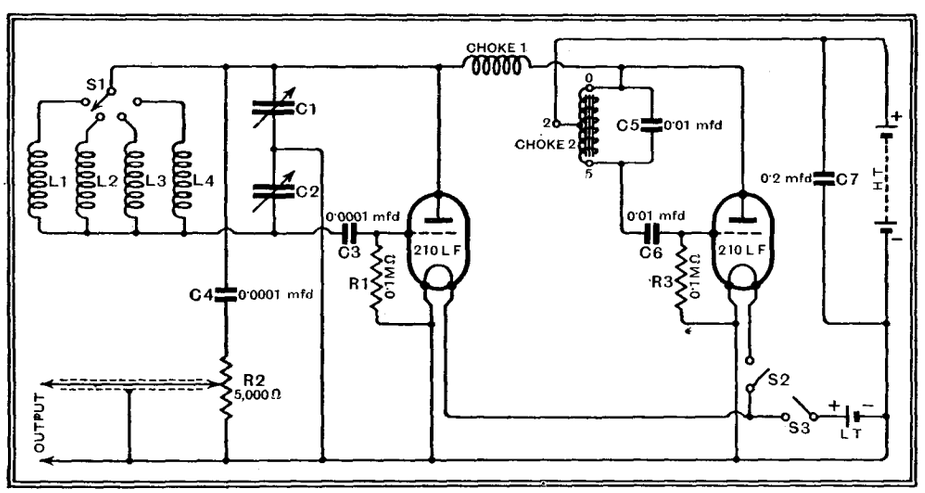


Fig. 1.—The complete circuit diagram of the oscillator is shown here, and it can be seen that the Colpitt's circuit is used for the HF oscillator, thus enabling simple coil switching to be obtained.

The Wave-Range

The second method of avoiding the use of plug-in coils involves the provision of a separate built-in coil for each range with switching. The increased complication is well worth while since it prevents any ambiguity as to the frequency. Harmonics are, of course, present, although perhaps not to the same degree as with the harmonic type of oscillator, but the relatively greater strength of the fundamental leads to no difficulty in 99 per cent. of practical cases.

Since the range-changing is to be accomplished by means of switches, it is obviously desirable to choose the oscillator circuit which permits the simplest form of switching provided that it is satisfactory in other respects. There are two oscillators which will function with a single untapped coil for each range, so that range-changing can be accomplished

Modulated Test Oscillator—

with a single rotary stud switch—the simplest possible arrangement. These two oscillators are the dynatron and the Colpitt's.

The dynatron oscillator is eminently satisfactory in mains-driven apparatus, but it is not so reliable with battery valves, and it usually requires an HT supply of not less than 70 volts. The Colpitt's oscillator, however, is very reliable, and with an adequate HT supply will function with almost any valve. With a suitable triode, an HT supply of only 15 volts is adequate for reliable oscillation, so that the circuit lends itself well to portable equipment with self-contained batteries. The only disadvantage of this oscillator is that it requires a split-section tuning condenser, but this is of minor importance when weighed against its many advantages.

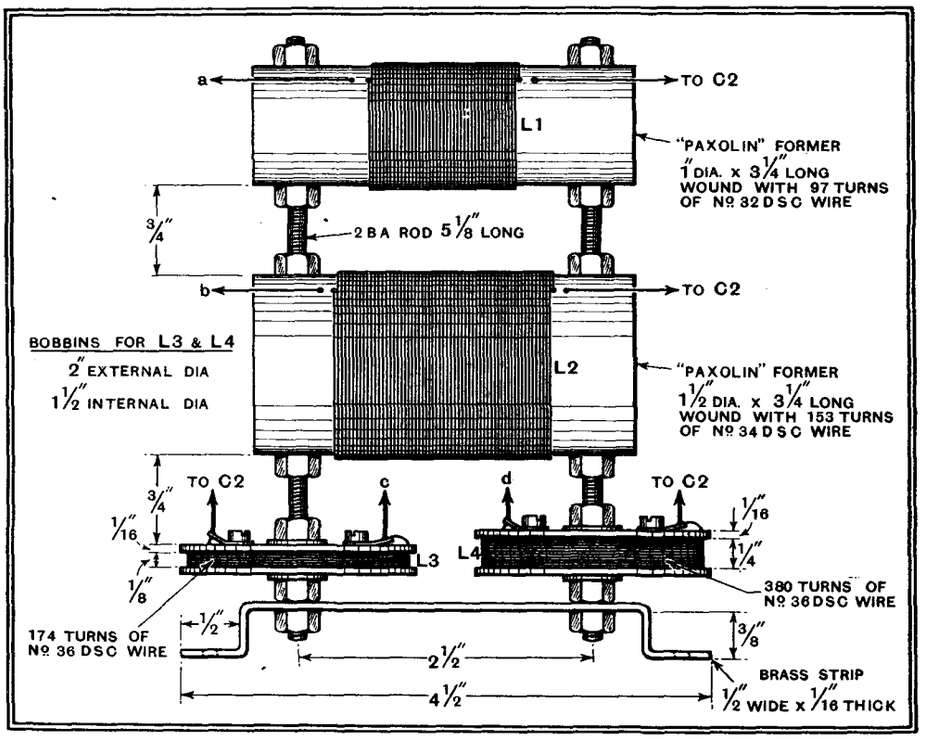
The Oscillator Circuit

The complete circuit diagram of the apparatus is shown in Fig. 1, and it will be seen that a Colpitt's oscillator is used for generating high-frequency currents, but a Hartley oscillator for the modulation frequency. The split-tuning condenser, C1 C2, consists actually of a standard 0.0005 mfd. two-gang condenser. The two sections are in series as far as tuning is concerned, so that the maximum effective capacity is 0.00025 mfd. With this capacity four coils are necessary for covering the required range and inductances of 8,800 μH., 2,200 μH., 550 μH., and 137.5 μH. give the following approximate bands: 100-230 kc/s, 200-460 kc/s, 400-920 kc/s, and 800-1,840 kc/s. In practice, the ratio of maximum to minimum frequency varies somewhat on the different bands owing to differences in the self-capacities of the coils.

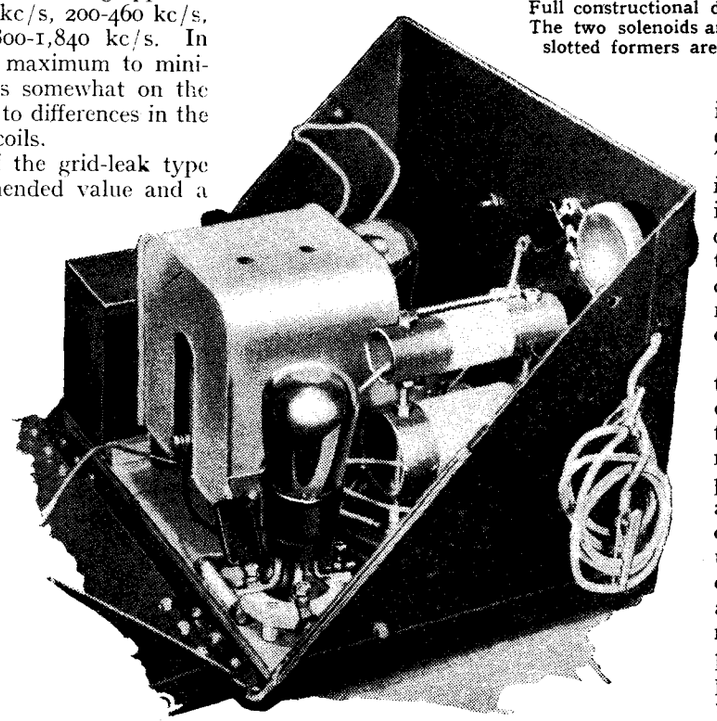
The oscillator is of the grid-leak type and with the recommended value and a 16.5 volts HT supply consumes only 0.6 mA. The low-frequency oscillator is fundamentally the same and draws the same current from the HT battery. A Hartley oscillator is used instead of the Colpitt's and modulation of the HF oscillator is effected by the simple expedient of including one half of the oscillator coil Ch2 in the anode circuit of the latter. A switch S2 is fitted in the filament circuit of this valve in order that an unmodulated output may be obtained when required, and, of course, the total current drawn from the batteries is then halved.

The whole apparatus, including batteries, is housed in a cast-aluminium case so that thorough screening is obtained in the simplest manner. The tuning dial selected is accordingly of the type which fits entirely outside the cabinet, for it would obviously be out of place to employ one which necessitates the provision of a large escutcheon hole. The dial has been carefully chosen for its mechanical suitability, for it has a direct drive for rapid tuning as well as a friction reduction ratio drive for accurate setting. In addition the scale is clearly marked and can be accurately read.

The output of the oscillator is taken by screened leads terminating in spring clips from the potentiometer R2, which is fed through the 0.0001 mfd. condenser C4 from one half of the oscillator tuned circuit. A simple attenuator of this nature meets most of the requirements, and its chief imperfection is that it exercises a slight effect upon the oscillator frequency. This effect is only appreciable when the control is set close to the maximum output position. The output is then approaching 1 volt and is much greater than is needed for adjusting most modern receivers. When appreciable attenuation is used the output control affects the frequency to a negligible degree, so that calibration should be carried out under this most widely used condition.



Full constructional details of the coils are given in this drawing. The two solenoids are wound on ebonite or Paxolin tube and the slotted formers are built up from discs of ebonite or Paxolin.



A rear view of the equipment showing the chief components.

No attempt has been made in the design to maintain the output constant at all frequencies, for this would greatly increase the complexity of the equipment and it is really unnecessary. The maximum output is secured at the lower frequencies and it is of the order of 1 volt RMS. It depends largely upon the HT voltage used, and can be considerably increased if desired by fitting a battery of higher voltage. The supply of 16½ volts recommended, however, enables sufficient output to be obtained for set adjustment purposes, and it is not so low that the valves will cease to function when the voltage falls a little. Actually oscillation can be obtained with 9 volts HT, so that there is an ample allowance for the running-down of the battery.

The LT supply is taken from a 2-volts unspillable accumulator of 12 a.h. (actual) capacity, and this should be cap-

Modulated Test Oscillator—

able of operating the oscillator continuously for some 60 hours. Equipment of this nature is rarely in continuous use, however, so that as far as the current drawn from the battery is concerned a single change should provide many weeks' service. If the battery is to be kept in good condition it is as well to remember, therefore, that recharging should be carried out periodically, and not necessarily only when the accumulator is discharged.

Complete drawings and details of the wiring will be given in next week's issue, and as these contain most of the information necessary for constructing the oscillator, little need be said here. It may be remarked, however, that the coils are assembled on two lengths of 2 BA. rod which are held by a metal bracket. The accumulator is held in place on two sides by the walls of the container, on a third by a component, and on a fourth by a wooden strip screwed to the base. In order to prevent it rising if the apparatus be tilted, a block of wood is screwed to the rear of the cabinet in such a position that when the cover is closed it rests on the accumulator and holds it firmly in place.

The coil construction is straightforward and calls for little comment. It is important, however, to wind the coils tightly, and particularly the two solenoids, otherwise the inductance will be likely to vary with small alterations in the positions of the turns, with disastrous results to the accuracy of calibration. Care should be taken to make the coils exactly to the specification, for only then will the calibration approach that of the original model. The apparatus will still function, of course, with quite large departures from specification, but the calibration may become so widely different that the ranges do not overlap, and this would necessitate the experimental readjustment of the windings.

(To be concluded.)

THE LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Two-gang condenser, 0.0005 mfd., **C1, C2** — **Polar "Minor"**
1 4in. length ¼in. shaft and shaft connector — **Bulgin**
1 Dial (General Radio Type 703A) — **Claude Lyons**
1 Coil assembly (see text), **L1, L2, L3, L4**
1 Choke, 3 henrys, tapped, **Ch2** — **Varley DP18**
1 HF choke, Ch1 — **Bulgin HF10**
2 Metallised resistances, 100,000 ohms, 1 watt, **R1, R3** — **Dubilier**
(Amplion, Erie, Ferranti, Graham Farish, Claude Lyons, Polar-N.S.F., Watmel)
1 Wire-wound potentiometer, 5,000 ohms, **R2** — **Claude Lyons Clarostat M-5**
2 Fixed condensers, 0.0001 mfd., **C3, C4** — **T.C.C. Type M**
2 Fixed condensers, 0.01 mfd., **C5, C6** — **T.C.C. Type M**
1 Fixed condenser, 0.2 mfd., **C7** — **T.C.C. Tubular Type 250**
(Dubilier, Graham Farish, Peak, Polar-N.S.F., T.M.C. Hydra)
1 Rotary switch, single-pole, 4-way, **S1** — **Kabi**
2 Toggle switches, on-off, **S2, S3** — **Claude Lyons 728**
(Bulgin)
2 Valve holders, 4-pin, baseboard mounting — **Eddystone 949**
2 Grid battery clips — **Gripso 36**
2 Wander plugs — **Eelex**
2 Spade terminals — **Eelex**
1 Screening cabinet — **Eddystone 975**
1 yard Screening sleeving — **Goltone**
2 Crocodile clips — **Bulgin CR6**
1 Accumulator, 2 volts, 12 amp.-hr., unspillable — **Ever Ready S121**
1 GB Battery, 16½ volts — **Drydex**
Valves: 2 Cossor 210 LF.

DISTANT RECEPTION NOTES

Frequency Spread of Paris Television

THE French authorities, I hear, are rather disappointed by the comparatively short range of the Eiffel Tower now that it is working on 206 metres. But since the official lists give its present power as only 5 kilowatts I hardly think that they could have expected any enormous service area. In any case, Parisians have little to grumble about in the lack of broadcasting, for they still have a plethora of stations, and they obtain much better all-round reception since the Eiffel Tower reduced its wavelength and its output power.

It was announced recently that the Eiffel Tower would shortly be radiating television transmissions of a compromise type, halfway between a high definition and low. The intention of those responsible is to send out a 60-line "vision" with twenty-five pictures a second. On hearing this I at once began to wonder whether there would not be a good deal of interference from these transmissions with other stations in the lower part of the medium-wave band. The formula for the total spread of a television transmitter is: number of pictures a second × number of scanning lines × ratio of longer to shorter side of image. For twenty-five 60-line pictures a second of ciné-film shape this works out at roughly 112.5 kilocycles. Were the Eiffel Tower to send out its television on 206 metres there would be a very serious interference with numerous other stations.

Actually, the transmissions will take place on about 175 metres, which corresponds approximately to a frequency of 1,714 kilocycles. If we subtract half the total television spread, or 56.25 kilocycles, from this, the result is 1,657.75 kilocycles, which means that the upwards spread should be comfortably clear of the stations at the very bottom of the medium waveband.

COBLENZ, which relays the programmes of Frankfurt on 251 metres, is Germany's latest transmitter, having been opened last month. The picture was taken just after the inauguration ceremony.

These "half-and-half" transmissions may be of considerable interest to experimenters, for they will serve to show how very much better 60-line television is than 30-line, and yet how far it falls short of possessing a real entertainment value. For myself I do not see very much point in inaugurating the service in this way if it is intended, as we are told that it is, to proceed later to 180-line or 240-line television on ultra-short wavelengths. However interesting the results that experimenters obtain with receivers, none of the apparatus that they buy or build for themselves is likely to be of much use when high definition transmissions come into being. It seems to me that our own policy of taking the plunge with 240 or even 360-line transmissions is much sounder, since there can be no question of apparatus becoming obsolete within a short time owing to increases in the number of scanning lines.

Motala's high-power transmitter appears to be working occasionally rather late in the evening. My own record shows that on most days of the week Motala is still rather poorly received, but every now and then the station is logged at splendid volume. This seems to point to intermittent use of the new plant. Radio-Roumanie, the 150-kilowatt Bucharest station, does not yet seem to have come into action, despite the announcement made some time ago that it was ready to do so. At any rate, Huizen continues to broadcast on 1,875 metres, and I have not noticed any interference with its transmissions.

D. EXER.

Elements of Loud Speaker Practice. By N. W. McLachlan, D.Sc., M.I.E.E. 160 pages, 92 illustrations, 6 diagrams. Oxford University Press, Warwick Square, London, E.C.4. 5s.

The knowledgeable wireless enthusiast, whose interest is primarily in developments in circuit design, often finds himself at a disadvantage when the discussion leaves the output stage and passes from an electrical to an acoustical basis. This state of affairs would be quickly remedied by a few hours' careful study of this succinct and authoritatively written handbook.

The section dealing with driving mechanisms is comprehensive, and, for the sake of completeness, descriptions are given of many types which have passed, or are passing, out of use; but the information relating to the moving-coil drive and its associated conical diaphragm occupies the greater part of this section. The treatment is non-mathematical, but simple relationships have not been excluded, and quantitative data are given to indicate the practical significance of the various phenomena described.

The distribution of sound from diaphragms and the effect of baffles and room characteristics are very fully explained with curves and diagrams.

That the book is fully up to date may be judged from the fact that there are references to nickel-aluminium magnets, piezo-electric drives, "tweeters," etc.

There can be no doubt that anyone who has assimilated this book will not only be in a position to take an intelligent interest in any discussion relating to the reproduction of sound, but will also be equipped to assess the merit of future developments in this important branch of broadcasting technique.

Practical Volume Expansion

Original Contrasts Automatically Restored

By L. E. T. BRANCH, B.Sc.

ONE by one, the various obstacles in the way of obtaining perfectly natural reproduction are being surmounted. In this article a practical system of "volume expansion" is described; its object is to restore the original contrasts in intensity which are normally masked in the process of recording or transmission.

THERE is no excuse to-day for not obtaining good quality reproduction from broadcast reception or gramophone records within the limitations imposed by the loud speaker. In other words, the output from an amplifier can without difficulty be made substantially uniform. A well-designed amplifier will also embrace quite large peaks in the volume intensity and handle them faithfully. The one remaining inaccuracy which is only just being thoroughly investigated is what is known as the volume range of the reproduction. The problem is broadly how to expand suitably the original volume range. Both in broadcast reception and gramophone records the original volume range is reduced; that is to say, the soft passages are recorded somewhat more loudly and the very loud passages are recorded more softly than the original. Where this is not done automatically in the microphone circuit it is almost invariably performed manually.

The purpose of this article is to describe a method of restoring automatically the volume range in the receiver that can be to-day successfully applied to gramophone reproduction, and which is also useful for experimenting on broadcast reception. As will be seen, the extent of the volume expansion is very simply adjustable down to zero when one obtains normal working without any correction. The basis of this method is very simple. It consists in replacing one of the amplifying valves by a new type of valve which has been specially developed for the purpose, and then adding one extra valve for obtaining the automatic control. Fig. 1 shows theoretically the essentials of the system in its simplest form. The pick-up is coupled by the condenser C1 to the first amplifying valve V1. This valve is a variable-mu triode and the amplification which it gives will be governed by the bias produced across the condenser C3. This bias is obtained by means of the valve V which is an ordinary triode coupled to the grid of V1 by the condenser C2. The point to be noted is that the grid of the controlling valve V cannot be coupled to any point later in the amplifier than the grid of V1. For instance, if it is coupled to the anode of V1 a loud passage on the record will cause the valve V to alter the bias of V1 so that this latter valve gives increased amplification, and this will clearly be effective on the anode of V1 and will further cause V to alter the bias of V1 in the *same* direction which can only result in a building-up of the signal with consequent unsatisfactory effects.

The bias battery B normally maintains a large voltage across C3, say 10 volts negative, under which conditions V1 gives only a low magnification. Now when a loud passage on the record is encountered the valve V produces amplified voltage at its anode, and these voltages are fed via the condenser C4 to be rectified by the "Westector" W which is connected to produce a rectified *positive* potential in opposition to the negative bias given by B. The "Westector" is in fact used in a similar way to its use in so-called "battery economiser" output circuits except in the present case the circuit must be arranged to give the maximum amount of rectified potential. The low-frequency choke may be replaced by a high resistance (e.g., 250,000 ohms) or another "Westector," or a transformer may be used as illustrated in Fig. 2 where the voltage to be rectified needs to be amplified further. In the latter case an ordinary step-up intervalve type transformer has been found to be satisfactory. The voltage given in this case can be doubled by using the voltage-doubler circuit indicated in Fig. 3.

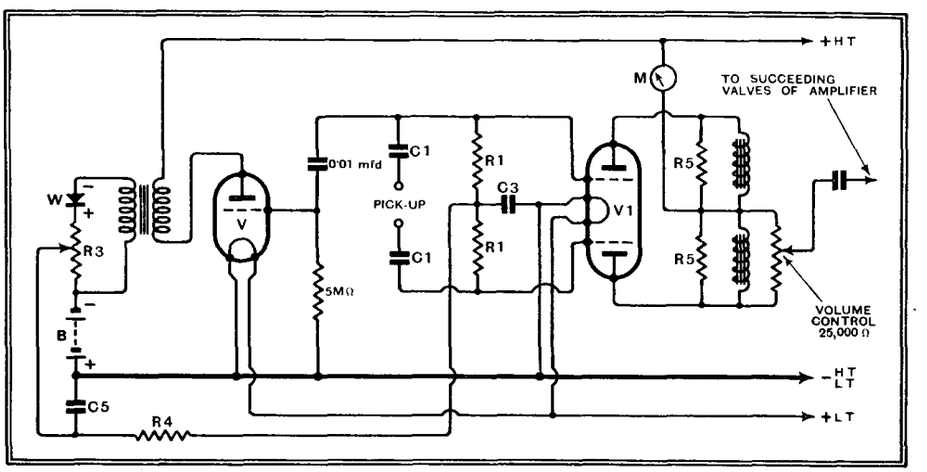


Fig. 2.—Circuit details of a practical arrangement for restoring contrasts.

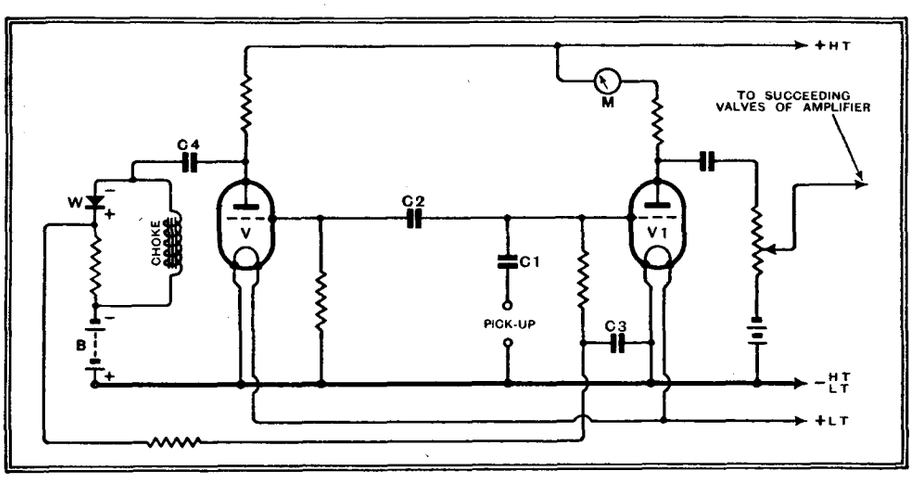


Fig. 1.—Skeleton circuit diagram illustrating the principles of volume expansion.

A Special Valve

In the circuit of Fig. 1 the valve V1, even when handling only a small input signal, would tend to produce harmonic distortion on account of its variable-mu characteristics. To avoid this the valve actually used in practice is a new variable-

Practical Volume Expansion—

mu double valve designed for normal push-pull working which balances out these harmonics, since the circuit is such that both halves of the valve are working

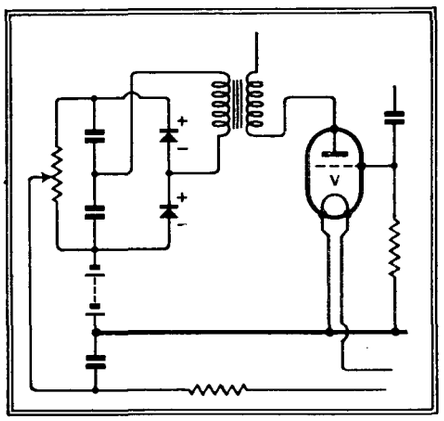


Fig. 3.—Modifying the circuit of Fig. 2 by adding a voltage-doubler.

on the same portion of the curve at any given moment. On the loudest signals the valve bias is, of course, lowest, and here the valve curve is straightest, which is what one needs if distortion is to be avoided.

A Practical Circuit

The circuit of Fig. 2 represents a practical arrangement needing little further explanation except that the anode of the variable-mu push-pull valve V1, which is the new Hivac V220, are connected by a centre tapped choke in order to combine the signals from each anode where the next following valve in the amplifier is a single one. If the next stage is also push-pull then, of course, the anodes of V1 can be each resistance-coupled to each of the next push-pull valves. Fig. 2 can be modified by substituting for the centre tapped choke a transformer having a centre tapped primary, and this is illustrated in Fig. 4.

The values of only a few of the components are of importance. First, the condensers C1 and resistances R1 are merely chosen so that the pick-up is not unduly damped. If C1 is 0.05 mfd. and R1 is between 0.25 and 1 megohm this should be suitable for any pick-up. The anode resistance R2 should be about two or three times the value of the impedance of the valve V which should be of the high-magnification type. The variable resistance R3 should be at least 250,000 ohms. The resistance R4 and condensers C5 and C3 must be very carefully chosen to give a suitable time constant. If these condensers are too small the control will be too jerky, whereas if they are too large there will be too much play. If C3 is 1 mfd. and C5 is 0.1 mfd. then R4 needs to be about 500,000 ohms. These values are found to give very satisfactory results with most records. The value of the standing bias at B should be such that the "idle" anode current of V1 is about 0.2 milliampere. This will rise slightly even on the weakest signals.

By inserting a milliammeter at M to show the change of anode current of V1 as the bias alters during the playing of a record one can watch the movement of the needle and note not only whether it responds too quickly (a reasonably slow response is advisable) but also whether it ever reaches the value indicating that the bias has fallen to zero. The current for zero bias is best first ascertained by taking an idle reading with the condenser C3 temporarily short-circuited. Then at no time during the playing should this value of current be reached. The remedy is to move the arm of the potentiometer R3 nearer to B. It is necessary to play a few records to find suitable adjustment for R3.

The resistance R5 should not be too high, otherwise the low frequencies will be attenuated at low volumes. R5 should be not more than approximately the impedance of each half of the centre-tapped choke or transformer primary, calculated at 30 cycles. Thus if a Ferranti AF3c is used this has a primary inductance under the present working conditions of about 200 henries, which means that each half has an inductance of about 50 henries which at 30 cycles is about 9,000 ohms.

Enhancing Light and Shade

The reason for the avoidance of a higher value for R5 lies in the fact that at high bias the impedance of the valve V1 increases enormously, up to at least 50,000 ohms, so that the impedance in the anodes must be kept substantially constant at all frequencies. With a low value for R5 the change of impedance effects efficient volume expansion. For example, the Hivac AC/V at −2V bias has an impedance of about 6,000 ohms, while at a bias of −12 V the impedance rises to 120,000 ohms. With R5 at 6,000 ohms this means that at −2V bias the stage gain is about ten times that at −12V bias. That is to say, the volume range of the record may be increased up to ten times, which is usually ample. An expansion of this extent enhances the light and shade on the record to a truly magnificent extent, and by comparison the uncorrected playing seems quite lifeless.

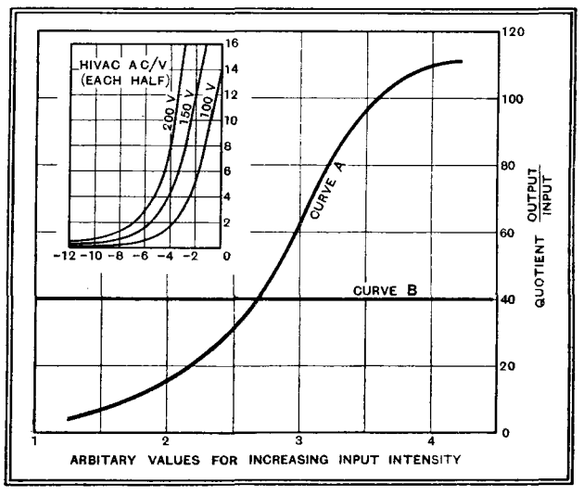


Fig. 5.—Curve A shows the volume expansion (measured at 500 c/s) using the Hivac AC/V in the circuit of Fig. 3. Without the expansion-controlling circuit the result is a straight line as shown by curve B. Any degree of expansion between these limits can be obtained by adjustment of the potentiometer R3.

The Hivac AC/V referred to above is the mains valve corresponding to the battery valve V1 shown in Fig. 2. In using the mains valve the battery B can be omitted and the bias obtained by a bias resistance in the cathode lead. This needs a loading resistance R6 of about 20,000 ohms so as to pass a standing current of nearly 10 milliamperes, in which case the cathode bias resistance R7 can be about 1,000 ohms, giving 10 volts bias and being adjusted so that the standing anode current of V1 is about 0.2 ma. No condenser is necessary across the bias resistance because under normal push-pull conditions the voltages produced across it are exactly balanced out. The condenser C3 is connected to the cathode as shown in Fig. 4, which also illustrates the application of two "Westectors" in series.

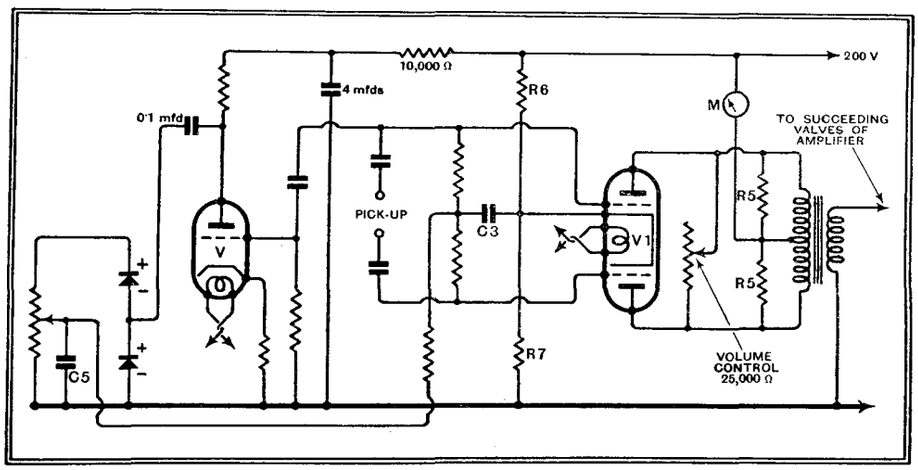


Fig. 4.—Showing the use of a transformer in place of a tapped choke.

CURRENT TOPICS

Events of the Week in Brief Review

Anti-static War

A FLEET of thirty-two cars is now patrolling Canada for the purpose of tracking down radio interference.

Television and the Public

A LARGE number of public "televiewing rooms" are to be opened in various parts of Berlin before next winter.

Post Office as Press Censors

THE German Post Office has issued instructions that all news and articles regarding German television must first be submitted to and passed by the Ministry of Posts before publication in Germany.

Propriety at the Microphone

THE Chinese broadcasting authorities have issued an edict forbidding swearing at the microphone and the dissemination of songs and stories "which cause naughty children to laugh." Further, there is a ban on ghost stories.

A Highbrow

MR. JAMES REID, a Fort William electrician, claims to have enjoyed broadcast reception at a higher spot in Great Britain than anyone else. Last week he took a portable set to the top of Ben Nevis, Inverness-shire—a height of 4,406ft.—and enjoyed clear reception from the Scottish Regional station.

Fighting Forest Fires

THE Swedish broadcasting system is being enlisted in the war against forest fires which, in view of the importance of the timber industry, can threaten a national catastrophe. In addition to talks on the folly of carelessness with matches and unextinguished cigarettes, the stations will be used to call the forest guards and local fire brigades immediately a fire occurs.

Mr. A. Fazalbhoy

INDIAN radio circles are mourning the death of Mr. Abdulla Fazalbhoy, a prominent figure in the cinema and radio business in India.

When, some years ago, the Government of India proposed to close down the stations in Bombay and Calcutta, Mr. Fazalbhoy worked hard for their retention. Eighteen months ago he opened Film City, one of the largest studios in India, which was designed after he had paid a visit to studios in England and Hollywood.

Radio at Paris Fair

THREE halls are to be devoted especially to radio in this year's Foire de Paris.

More Kilowatts

THE famous Czechoslovakian transmitter of Brno is shortly to be moved to another site with a power increase to 100 kilowatts.

Polyglot Italy

ITALY is heading for the polyglot record. In addition to Arabian, Albanian, Greek, and Bulgarian, the Italian broadcasting stations now include regular items in Roumanian.

Twenty Million

RUSSIA now claims to have twenty million listeners served by sixty-six broadcasting stations, according to reports presented at the Moscow Conference of the U.S.S.R. Radio Committees. Last year there were 140,000 hours of transmission given in sixty-two languages.

5-metre Tests in London

AS announced in last week's issue, directional and omni-directional 5-metre transmissions are to be carried out on Sunday, May 19th, by the International Short Wave Club on the roof of the *Daily Telegraph* building in Fleet Street, London. The call sign of the transmitter will be G5KA, and the transmissions will be in both code and 'phone, using the following schedule:—

Directional aerial N. and S.:—11-11.15 a.m.; 12-12.15 p.m.; 3.45-4 p.m.

Directional aerial E. and W.:—1.45-2 p.m.; 2.45-3 p.m.

Omni-directional aerial:—11.30-11.45 a.m.; 12.30-12.45 p.m.; 2.15-2.30; 3.15-3.30; 4.15-4.30.

TELEVISION IN FRANCE. Mme. Bretty, of the Comedie Francaise, photographed in the studio of Paris P.T.T. when the 60-line tests were inaugurated last week. Transmission is on 175 metres.

Two Shakespearean plays, "The Merry Wives of Windsor" and "As You Like It," were adapted for broadcasting during 1934.

Howler

THE broadcast of the Cup Final at Wembley aroused considerable interest in France, and incidentally the event gave rise to the prize howler of the week. Describing the scene before the match, *Le Journal* dealt with the broadcasting of the community singing while the waiting crowds were enjoying their *alfresco* lunch. One of the items, remarked the journal, was "A Bite with me."

A special code word will be given during each transmission for the purpose of identifying reports. During the intervals the members of the Club will be listening for other stations on 5 metres and also on 40 metres for any stations wishing to report reception of the ultra-short wave signals.

A special appeal is made for listeners to report on the tests. It is hoped to secure reports from over two hundred miles distant.

The Ultra Short Wave Two, which was described in the issue of this journal dated June 16th, 1933, is a very suitable receiver for those who wish to take part.

A limited number of copies of the issue can still be obtained from the Publishers, Dorset House, Stamford Street, S.E.1.

A Remarkable Map Offer

READERS of *The Wireless World* who are motorists will be particularly interested in *The Autocar* this week. An announcement is made of a remarkable map offer. *The Autocar* is published on Fridays, and is obtainable everywhere at fourpence.

5-metre Pirates

AMERICA is being swamped with unlicensed ultra-short wave stations, and Major K. B. Warner, Secretary of the American Radio Relay League, states that the assistance of the League has been requested by the Federal Communications Commission to aid in suppressing these illegal activities.

It seems that a number of supply houses, particularly of the mail order variety, have marketed 5-metre "transceivers" which are compact, self-contained portable transmitting and receiving units. These are sold to unsuspecting purchasers with no warning concerning the radio licence situation.

Delinquents run the risk of a fine of not more than 10,000 dollars or imprisonment not exceeding two years.

Medical Advice by Wireless

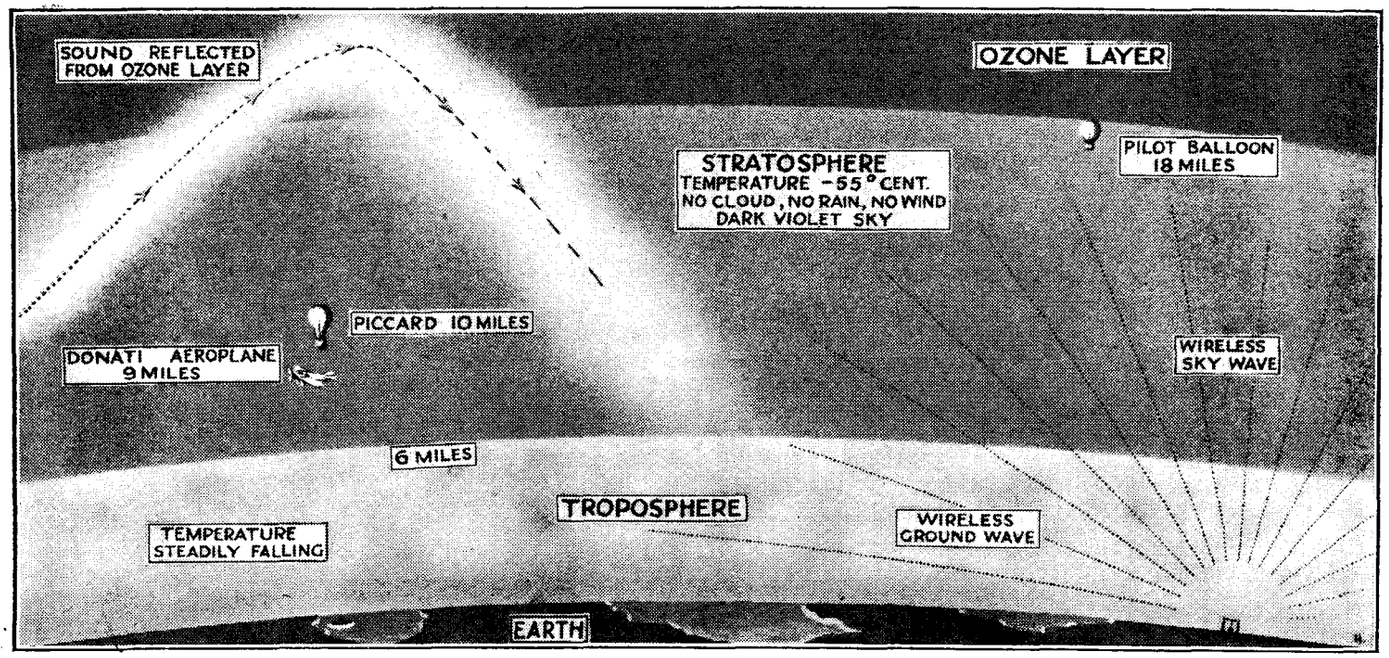
THE International Centre of Medical Radio-Communication, which was formed in Rome a few weeks ago under the honorary presidency of the Marchese Marconi, has given a first proof of its utility and efficiency, states *The Times* correspondent in Rome.

On April 7th the captain of the Italian steamer, *Perla*, then in the middle of the Atlantic, sent a wireless message to Professor Guida, the director of the centre, asking for guidance in the treatment to be given to a stoker who was seriously ill. The sick man had a high temperature accompanied by violent convulsions. The centre consulted a specialist by telephone and was able, after a few minutes, to transmit to the captain of the *Perla* the treatment he should apply. This brought immediate and lasting relief to the patient.

Wireless and the Atmosphere

II.—The Stratosphere, the World of Fair Weather and Intense Sunshine

By R. T. BEATTY, M.A., B.E., D.Sc.



THE previous article dealt with the thin layer of air called the troposphere, which envelopes the earth to a height of six miles. It is the weather zone, the zone of wind and rain, of fog and cloud, of birds and aeroplanes, and also the region of directly received wireless signals. The present instalment introduces the stratosphere, a calm, cold, dead world of fair weather and intense sunshine, roofed by the ozone layer where for the first time we encounter an electrified region foreshadowing those which in still higher regions have a profound effect in deflecting and spreading wireless rays over the earth's surface.

UP to a height of six miles or so we picture a scene of rising columns of warm air and descending columns of cold air, so that there is enough circulation to keep the air thoroughly mixed. As mentioned in the previous article, the direct rays of the sun have but little power to warm the air through which they pass. It is by direct contact with the warm surface of the earth, and to a smaller extent by absorbing heat radiation long wavelength from the ground, that the rising columns of gas are heated. As the air drifts upwards it expands and so steadily becomes colder, and we might at first sight imagine that this process would go on till, on the outskirts of the atmosphere, the temperature would approach the cold of interstellar space.

Absolute zero: 273 degrees below zero Centigrade.

The Stratosphere

But the temperature does not in reality drop to a level approaching this value, for the simple reason that at a height of about six miles, where the temperature has fallen to −55° C., the heat radiated away per second by the gas is now so small that it is just balanced by the heat absorbed from the heat waves radiating upwards from the ground. This ground radiation is just as strong six miles up as it is at the earth's surface; an unexpected result, perhaps, but one which is easily seen to be true by help of Fig. 1. For suppose that you are at a certain height and surrounded by a sphere opaque to heat radiation except for a small window which is perfectly transparent. Then you will see a plot of ground from which, and from which only, heat will reach you. Now imagine that you have risen to twice this height. The visible plot increases to four times the area, but since by the inverse square law the radiation received from each square foot of ground is only a fourth of what it was before, the heat pouring in through the window and reaching the centre of the sphere is $4 \times \frac{1}{4}$ times, i.e., exactly the same as at the lower level. Now, as we open one window after another the same thing will happen, so that finally, when the whole sphere is removed we have the result that the heat received (and absorbed) is the same at any height, so long as the height is so small (say, 100 miles) that the earth below can still be regarded as a flat surface.

Well, then, the position is that at or above a height of six miles air adjusts itself to a temperature (−55 deg. C.) at which it receives just as much heat as it loses, and accordingly we should find a calm, cold region devoid of wind and cloud,* for if the temperature is the same everywhere there is no reason why wind should blow. This is the stratosphere; it reaches up to a height of eighteen miles, and then, owing to the presence of a layer of ozone which we shall describe presently, the temperature once more begins to change.

This constancy of temperature in the stratosphere has frequently been verified by inspection of the readings of recording thermometers carried by pilot balloons which have ascended as high as eighteen miles.

The Ascent of Man

Till 1931 no human presence had ever invaded the stratosphere, but meanwhile

* This is true most of the time, but occasionally wind and thin cloud have been detected in the lower layers of the stratosphere.

Wireless and the Atmosphere—

Auguste Piccard had been constructing a balloon to carry an airtight aluminium sphere capable of holding two men, and in this he hoped to ascend into that unbreathable Arctic air. His first attempt was a failure, but on May 27th, 1931, in the still hour which ushers in the dawn, the anchor ropes were released and Piccard and his companion set off at twenty miles an hour—upward bound for the stratosphere.

He reached a height of ten miles. Nine-tenths of the atmosphere lay below him; the mercury had dropped to three inches. Overhead, away from the sun, the sky was dark, though not dark enough to reveal the stars, and of an intense violet purple; we do not see this colour from the ground, for it is absorbed by the column of air above us. Europe lay below, visible for 280 miles in every direction, and the Rhine, looking like a rivulet, was clearly seen. But it was the silence, the perfect and uncanny silence, that they feared. Silence is so hard to come by in these days that man is uneasy in its presence. And a strange thing happened: the interior of the gondola rose to a tropical temperature, though outside its thin wall was the cold of the stratosphere. All day they hung, a speck in the sky, till the chill of sunset checked the lift of the balloon and they drifted down to make a safe landing on a mountain glacier.

Wireless Waves at Low Levels

Let us now look down from the ceiling of the stratosphere and regard the stream of wireless messages which pass in the region below. First there are the waves which follow the curvature of the earth, spreading like a thin film over the surface as if their feet were forced to tread on the ground. It is not on account of any mysterious affinity for the earth's surface that they follow this curving path, but simply because long waves of any kind can turn corners and follow curves more easily than short waves can.

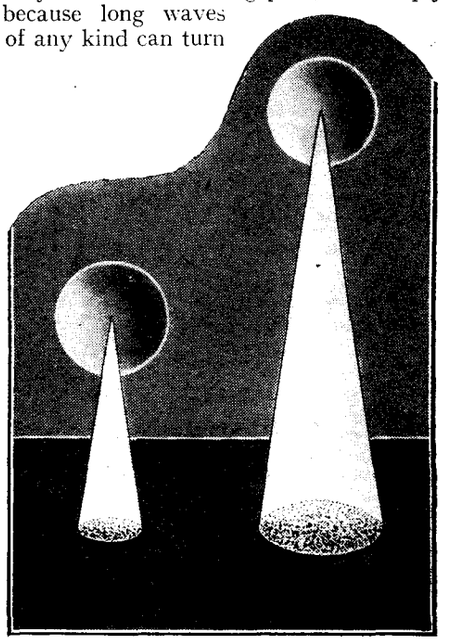


Fig. 1.—As explained in the text, the heat received by radiation from the ground does not diminish as we go up in a balloon.

Even light waves, less than a thousandth of a millimetre long, bend slightly round corners, the red waves more than the shorter blue ones. On looking at a distant street lamp through a handkerchief we see a brilliantly coloured pattern due to the unequal bending of different colours round each thread of the fabric. Waves of sound several feet in length spread extensively round walls and buildings and curve outwards from the cone of a loud-speaker, while the high notes of short wavelength tend to keep along the axis. And wireless waves measuring hundreds of metres from crest to crest bend still more easily.

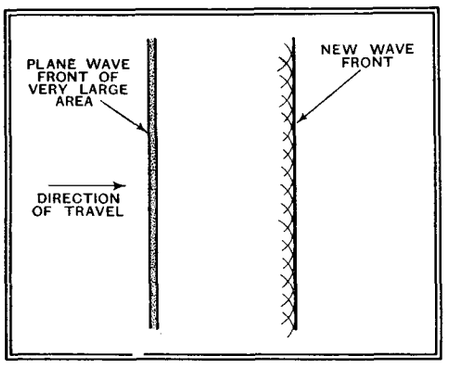


Fig. 2.—Every point in a plane wave sends out a wavelet: these wavelets combine to produce a new plane wave.

This departure of waves from the straight path puzzles many students. But the difficulty disappears as soon as we begin to think about what a wave really is. Take the case of a pure musical tone reaching us from a source a mile away. Pulses of compressed air arrive at regular intervals with pulses of rarefied air sandwiched in between. Any sheet of air which is all in the same state, say, of compression, is called a wave front, and though each wave front is a spherical surface diverging from the source, we may regard any small portion of it as flat by the time it has travelled a mile. This is a plane wave front, and the first question is: Why does it remain plane as it travels on?

Well, suppose the whole front removed except for a tiny patch. This patch of compressed air in expanding will send out a spherical pulse of compressed air in all directions. Now every part of the wave front sends out a wavelet of this kind, and the result is that after, say, 1/1,000th second the wavelets all touch a new plane 13 miles ahead of the original plane. This is the new wave front; it has been formed by innumerable diverging wavelets, but the result is just as if the wave consisted of a solid sheet of compressed air travelling broadside on at the speed of sound.

But now suppose an obstacle in the way, as in Fig. 3. At any point P in the region of shadow, wavelets will arrive from the points 1, 2, 3, 4 of the wave-front. If we make the line 2P half a wavelength longer than 1P, and 3P half a wavelength longer than 2P, and so on, then 2 will arrive at P just out of phase with 1, and so these two disturbances will nearly cancel; similarly, 4 nearly cancels 3, and so on, and the intensity at P is much less than it would be if the obstacle were removed. As P sinks deeper into the shadow the cancellation becomes more complete.

Thus there is no sudden transition from sound to silence, but a gradual decrease in intensity as we plunge deeper into the shadow. In other words, sound bends or *diffracts* round corners. Since Fig. 3 is drawn to a scale of wavelengths it gives a picture which is true for radiation of *any* wavelength. Thus, for a note of 1,000 c.p.s., whose wavelength is about one foot, P is ten feet inside the shadow and a hundred feet away from the obstacle. For wireless waves 100 kilometres long the same proportion of energy is diffracted to reach P, if the distances are 1,000 and 10,000 km. While for given light, wavelength 1/2,000th of a millimetre the distances become tiny, for P is now 1/200th mm. inside the shadow and 1/20th mm. away from the obstacle. For wireless waves, then, the bending is on a grand scale. For a given angle of diffraction, as the wavelength increases, the point at which the intensity falls to any specified fraction recedes farther and farther away from the obstacle.

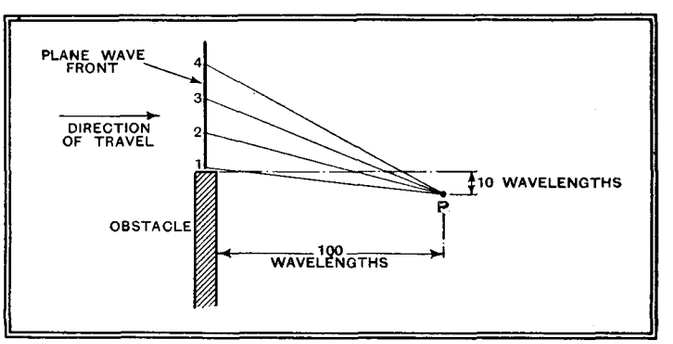


Fig. 3.—The wavelets from the plane wave tend to cancel out at P owing to phase differences.

The Ground Wave

When the single obstacle of Fig. 3 is replaced by a continuously curving obstacle, such as the earth's surface, the same kind of bending into the region of shadow goes on. Though the mathematical investigation is formidable the final result is a very simple one and its physical meaning is easily grasped. It turns out that as the wave from the transmitting aerial pours over the horizon the signal intensity, expressed in (millivolts per metre)^2, falls off in such a way that it can be expressed as the product of two terms.

Fig. 4 shows waves being diffracted

Wireless and the Atmosphere—

round a quarter of the earth's surface. It is evident that at the source the rays diverge in all directions so that the intensity varies inversely as the square of the distance, falling to quarter value every time the distance is doubled. But the

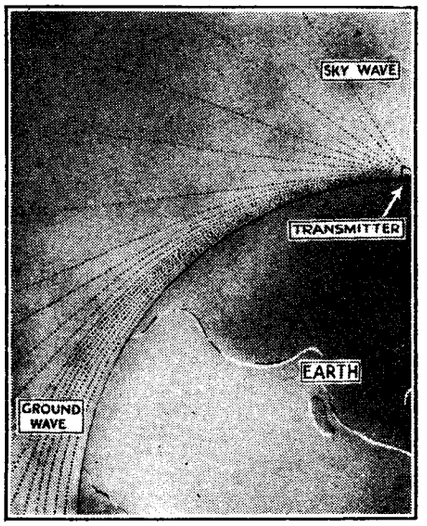


Fig. 4.—Wireless waves bending round the earth's surface.

diffracted rays pour round in a thin film and accordingly the disturbance spreads only in two dimensions, like the diverging ripple from a stone dropped into water, and so the intensity varies *inversely as the distance* instead of the square of the distance.

The first term gives this law of inverse distance. If the wavelength were infinitely great this term would be sufficient, so that, for example, the intensity 1,000 km away from the transmitter would be one-tenth of the intensity at 100 km. But for waves used in broadcasting the second term is important. It expresses an attenuation which depends on wavelength and is greater the shorter the wavelength.

If we had a receiver with a perfectly linear detector then the loud-speaker intensity would always be proportional to the incoming high-frequency intensity at the aerial, i.e., to (millivolts per metre)^2, and so, as in Fig. 5, we could plot the intensity level in decibels calculated from the diffraction formula at various distances. The results take no account of losses due to eddy currents induced in the ground; they are strictly true only for a perfectly conducting earth, but it will presently be shown that even for the actual earth they are not far from the truth at great wavelengths.

Ground Wave from Different Stations

Now place our ideal receiver 100 kilometres from a station and turn up the volume control till the loud-speaker output is 130 decibels above the threshold of silence, i.e., an intensity at the limit of the ear's endurance (a marvellous receiver, this!). Let us also arrange with the station operator to broadcast on different wavelengths with the proviso that he must keep the station strength so adjusted that the output of our loud speaker (100 km away) remains constant in loudness. Then whisk our set away 1,000 km (620 miles) from the station and note how the intensity falls off.

If the station begins on an infinitely long wave (an impossible state of affairs, but let it pass) we see from Fig. 5 that the sound intensity level falls by only 10 decibels, a hardly noticeable amount. An 18-kilometre wave, like that from Rugby, is attenuated by 21 decibels—the sound output is now that of two very loud motor horns 20ft. away. Perhaps it would be better to show the results in the form of the following list:—

Wave-length of Station.	Decrease in level of sound at 1,000 km.	Loudness of Sound.
Infinite ..	10 decibels	Absolutely unbearable.
18 kilometres	21 ,	2 super hooters at 20ft.
1.4 „ ..	36 „	Pneumatic riveter at 40ft.
300 metres ..	54 „	Man shouting at 4ft.
50 „ ..	90 „	Soft radio music.
10 „ ..	146 „	Not a whisper.

According to the diffraction formula, then, the attenuation of the ground wave increases enormously at short wavelengths. In the next article we shall see how far these results tally with observation, and shall merely remark here that, as shown

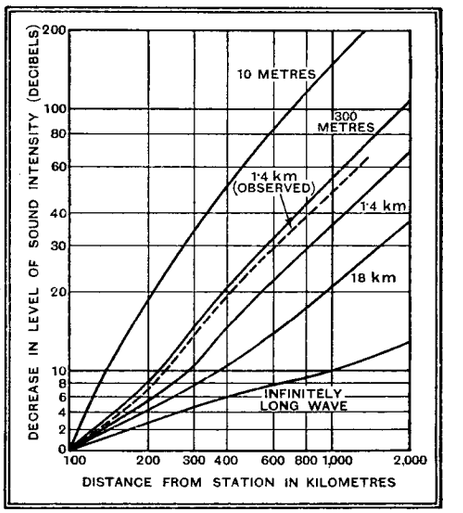
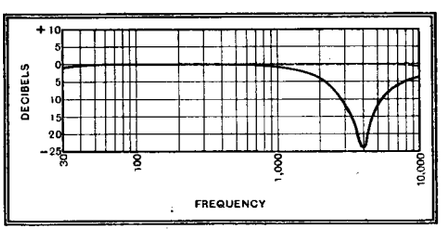


Fig. 5.—With a copper plated earth and no reflection from the sky, loud speaker intensity would decrease with increasing distance as shown.

by the dotted curve in Fig. 5, we are not far wrong down to 1.4 km waves in attributing the observed intensity at distances of 1,000 km to diffraction (i.e., bending) alone.

R.G.D. Microphone Amplifier

THIS amplifier has been specially designed for use with the R.G.D. Types CM1 and CM2 piezo-electric microphones. It is operated entirely from AC mains, and the circuit consists of three stages resistance-capacity coupled. The first



Frequency characteristic of R.G.D. microphone amplifier. The dotted curve was taken with the filter disconnected.

valve is of a type designed for low microphonic noise and minimum electrostatic pick-up, the shielded grid input lead being taken to a cap at the top of the valve. The output stage is designed to work into an impedance of 2,000 ohms, so that long, unshielded leads (up to 150ft.) may be used to the main amplifier.

The amplifier was tested with the inexpensive CM1 microphone, and gave very natural and clear-cut speech, uncoloured by any obvious resonance. The combination is remarkable for the low level of background noise. Mains hum is entirely absent, even on telephones, and if there is a slight trace of hiss at full volume it is due to valve noise rather than to the microphone.

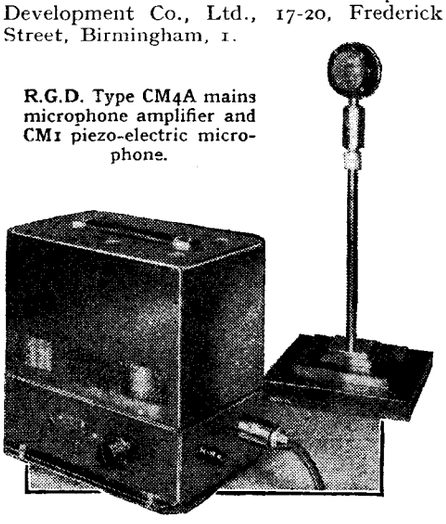
Working into a 2,000-ohm resistive load, an average output of about 1 volt RMS was obtained when speaking at a normal level about 3ft. from the microphone. The amplifier is designed to deliver much higher outputs than this, however, and the microphone itself is not acoustically overloaded by loud sounds.

For use with the CM1 microphone a filter is incorporated in the amplifier to compensate for a peak in the microphone characteristic. Without the filter the amplifier is flat from 30 to 10,000 cycles within 1 db.

The price of the CM4A amplifier is £12 10s., and the CM1 and CM2 piezo-electric microphones cost £7 10s. and £15 respectively. The table stand illustrated, complete with screened plug and 20ft. of flexible screened cable, is £2 10s. extra.

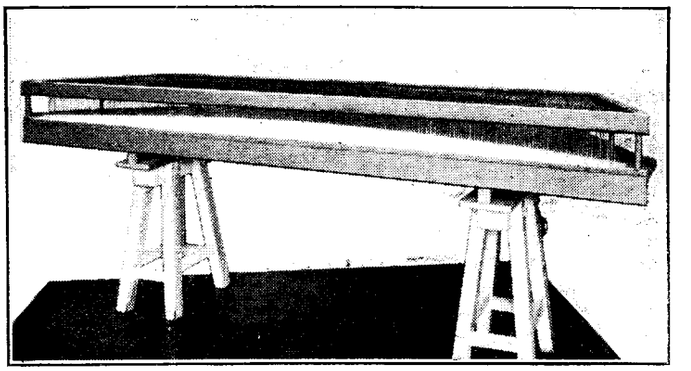
The makers are the Radio Gramophone Development Co., Ltd., 17-20, Frederick Street, Birmingham, 1.

R.G.D. Type CM4A mains microphone amplifier and CM1 piezo-electric microphone.



An Acoustic Spectroscope

Optical Principles Applied to Sound Analysis



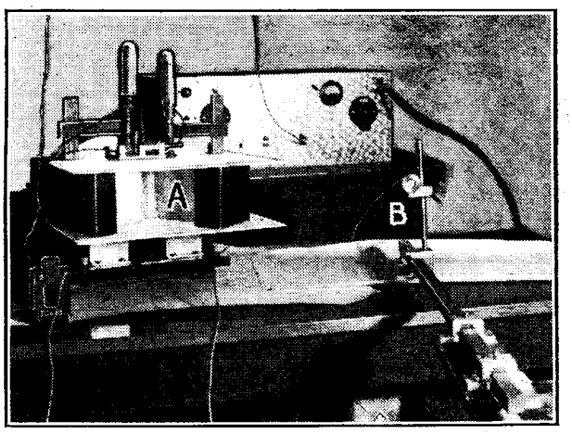
Acoustic diffraction grating designed for ultra-sonic frequencies from 45,000 to 50,000 cycles. There are 300 elements, the length is 3 metres and the theoretical dispersion at the focus is 8 cms. per 1,000 cycles.

A COMPLEX sound wave is easily analysed into its constituent part by heterodyne or bridge methods, provided that its amplitude is steady and that the duration of the sound can be maintained indefinitely while the series of adjustments and readings are taken. Where the sound is of short duration and of changing intensity, as, for instance, in the study of noise problems, a rapid, if not an instantaneous picture of the energy distribution at all parts of the sound spectrum is essential.

Several methods of achieving this result have been suggested, and one of the most interesting is due to Dr. E. Meyer and E. Thienhaus, of the Berlin Engineering College. In view of the fact that the problem presents many similarities to the analysis of the light spectrum, they have logically sought to apply optical principles.

The simplest method of analysing light into its constituent parts is by refraction through a prism. In all serious spectroscopic work, however, a "diffraction grating" is used. This consists of a number of closely ruled non-reflecting lines or grooves on a highly polished concave surface and the spectra are formed by interference due to the difference in phase of the light reflected from the regularly spaced elements. The full theory of the diffraction grating is, however, too involved to give here, and readers requiring further information are referred to advanced text books on optics.

There is no difficulty in applying the principle to the analysis of sound waves in air and the grating then consists of a number of equally spaced vertical rods arranged in an arc, the sound spectrum formed by the interference of the alternating reflecting rods and absorbing spaces being explored by a microphone instead of the eyepiece used in the optical spectroscope. The resolving power of a grating depends on the width and spacing of the elements in relation to the wavelength, and in the case of light the difficulty is to rule the lines sufficiently close together without breaking down the reflecting ridge between. In the acoustic case, however, calculation shows that a grating of the dimensions of a fair-sized boundary fence would be required for the wavelengths of the normal acoustic spectrum.



General view of associated apparatus showing (A) ribbon loud speaker unit and (B) exploring microphone mounted on radius arm.

To overcome this difficulty and to make the apparatus suitable for laboratory use, Messrs. Meyer and Thienhaus employ an ultra-sonic frequency (45,000 cycles), for which a comparatively small grating is required, and modulate this basic frequency with the sound frequencies to be analysed.

The schematic arrangement of the apparatus is shown in Fig. 1. The sound to be analysed is picked up on a microphone, amplified and passed to a balanced modulator supplied with 45 kc/s from a separate oscillator. The carrier frequency is suppressed in the modulation process and only the sidebands appear in the output. At this point a filter is introduced to eliminate the lower sideband, leaving, on the assumption of an input of 0 to 5,000 cycles, a band of frequencies from 45,000 to 50,000 cycles. After further amplification these ultra-sonic frequencies are converted into sound waves by a specially designed ribbon loud speaker. The reflected sound energy from the grating is picked up by a high-frequency microphone mounted to move through an arc and explore the resulting sound spectrum. The arc can be divided off and calibrated directly in terms of the original low-frequency sound.

Permanent Records

By coupling the movement of the exploring microphone with a recording camera and using a reflecting galvanometer for the indicating meter, a permanent record of the whole spectrum is rapidly obtained. The spectra of an organ pipe and of the complex sound from a spark discharge are shown in Fig. 2.

For visual observation of rapidly changing conditions a revolving mirror

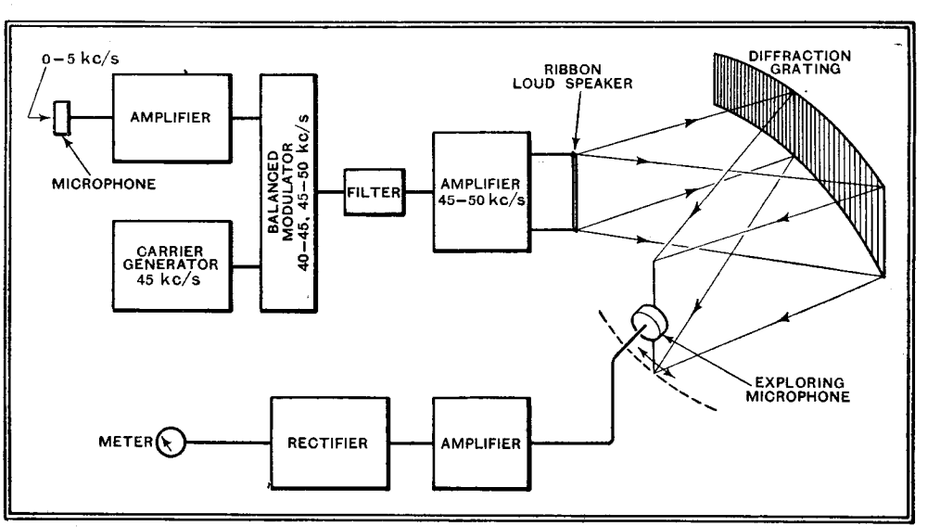


Fig. 1. Schematic arrangement of apparatus for producing and exploring acoustic spectra.

An Acoustic Spectroscope—

coupled to the swinging microphone could be employed, and there are no doubt many similar applications of what is undoubtedly a very ingenious and practical method of sound analysis.

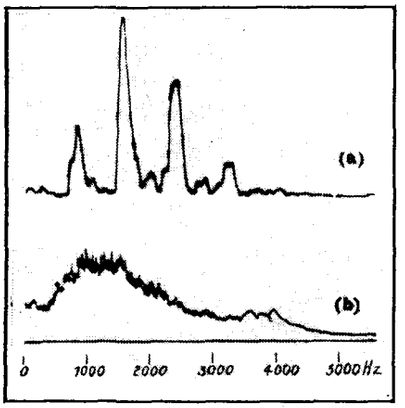


Fig. 2. Photographic records of the continuous sound spectra of (a) an organ pipe with overtones, and (b) the sound from a spark discharge.

Random Radiations

By "DIALLIST"

Smaller Battery Sets ?

ONE rather deplorable result of the recent upheavals in the high-tension battery market may be the disappearance, in ready-made form at any rate, of the battery-operated superheterodyne and of the larger straight receiving set designed for good volume in combination with the highest attainable quality of reproduction. The position is that nearly all commercial sets have to be designed to-day to work from high-tension batteries whose economic load is certainly not more than 10 milliamperes. That you cannot obtain large volume and good quality without the expenditure of a considerable number of milliamperes is axiomatic, and the designer who is limited to a mere 10 must economise plate current in every possible direction. I shall not be surprised to see receiving sets this coming year falling into two chief classes: the mains superheterodyne and the three-valve battery set. There will not, of course, be many three-valve mains sets, though now that it is becoming so little more expensive than the straight with a smaller number of valves, the mains superheterodyne is increasing in popularity.

Not all that it Seemed

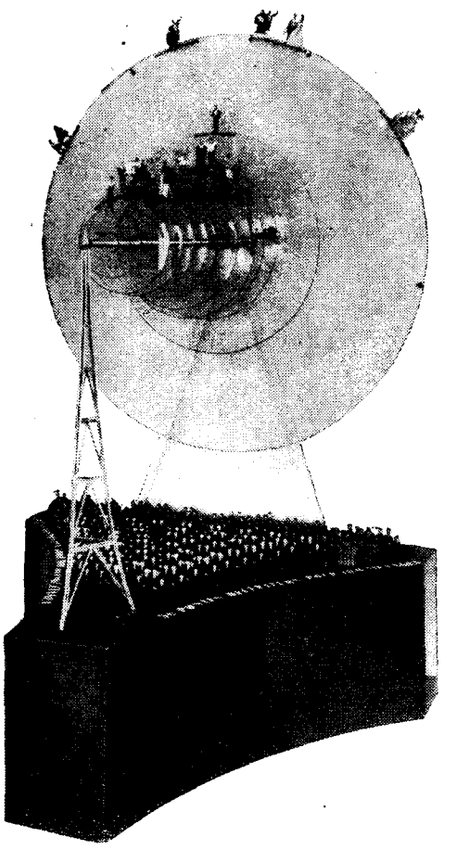
It appeared when it was first introduced that class B amplification might prove to be the salvation of the battery set. It enabled something approaching the volume and the quality of the mains set to be obtained, and tests made with delicate apparatus showed that the average current taken by the two plates of the output valve was something surprisingly small. This being so, was there any good reason why sets incorporating class B should not be operated from small dry-cell high-tension batteries?

There was a fly in the ointment, though its presence was not realised for some time. It is this: if you run a small H.T.B. under a steady load of, say, 6 milliamperes for four hours a day it will last for a very long time because the depolariser within its cells is not being given more work than it can perform with fair efficiency. But take a similar battery and put it under an *average* load of the same amount, made up of peaks rising to 30 or 40 milliamperes and troughs in which the current drain is very small, and it won't last anything like as long as it should in theory. The reason is that each of those peaks grossly overloads the battery, with evil results to each individual cell. To take an analogy, one could easily walk twenty miles in a day at an even pace. But were one to try to cover the distance in a series of spurts and crawls it would be a most exhausting business.

A "Sound" Item

ONE of the big American chains of broadcasting stations has recently introduced a feature which leaped at once into popularity. This is the Pathé News of the Air. The idea is to give once or twice a week from broadcasting stations a topical news bulletin on the lines of the well-known cinematograph films, though, of course, without the vision part. The Pathé News of the Air contains spoken accounts of all kinds of interesting happenings, together with sounds recorded on the spot, which produce the most realistic effects.

The B.B.C. has been doing something of the kind for a long while in a spasmodic way, and no doubt the Americans have borrowed the idea and improved upon it. Why shouldn't we reborrow it and make our news bulletins, not every night, but, say, two or three times a week, far more graphic than they are at present? The B.B.C. is well provided with the necessary apparatus, and it has plenty of men on its staff who are capable of working out the possibilities of the idea to the fullest.



AT THE BRUSSELS INTERNATIONAL SHOW. This striking exhibit of the Danish broadcasting organisation gives three-dimensional statistics regarding licence figures and set construction. The glass discs show the relative amount of time allotted to various types of programme material.

The R Question

ONE sees some queer criticisms of the English that announcers use. One that I have come across several times of late is that they don't sound the final "r" in words such as father or vicar or butcher. Why on earth should they, unless they be Scotsmen or Irishmen? In the English of England that kind of "r" has long been practically silent. Of course, you don't want an affected pronunciation like fathah or vicah; but, equally, you don't want fatherrr or butcherrr. Some announcers have one terrible trick with the letter "r" which, to many people, is even worse than the dropping of h's. This is the making of such horrible sounds as "MariaRand Henry." Here is something on which the B.B.C.'s committee on pronunciation might sit—and sit hard.

Reducing the Dance Bands

YOU may have noticed that comparatively few dance bands are now used for broadcasting purposes. The B.B.C. department concerned has been doing some weeding out, for it finds that it does not necessarily follow that because a band is good for dancing purposes it is also good for broadcasting. The microphone, sternest and most impartial of critics, has a way of picking out and emphasising faults that might otherwise go unnoticed.

It is really good news to hear that the B.B.C. has declared war on "excessive and inferior crooning." For myself, I should be inclined to apply those epithets to all crooning, but if we are to get rid of the worst exponents and the least alluring kinds of bleating there will be few who will not welcome this step as one in the right direction.

Painful Pleasures

IF we English takes our pleasures sadly, Americans appear positively to revel in misery. One of the star items announced as a weekly feature by WLW, the 500-kilowatt Cincinnati Station, is the Dreary Blues. We are told that "the programme will introduce in characteristic manner deep indigo selections." The names of some of these suggest that they are sufficient to give listeners the proverbial pain in the neck.

Let's hope that this kind of thing will stay on the far side of the Atlantic. We will remain content with our Meteorological Deep Depressions.

Television from Gramophone Records

A RECORD which will produce a 30-line picture when coupled up to a television receiver by means of a pick-up is being produced by Major Radiovision Co., of 10, St. Christopher's Place, W.1.

The record will be double-sided, playing for six minutes on either side, and will be sold at the price of 7s. Twelve different pictures will be found on either side.

These records should prove valuable to experimenters and for demonstration purposes. The producers state that one stage of LF amplification is quite sufficient for the operation of the record. If a negative picture is obtained, reversing the pick-up leads will produce a positive picture.

Short Waves and the Amateur

"Blind Spots" in the Short-Wave Receiver

By G2TD and G5KU

THE often noticed erratic performance of the simple regenerative detector circuit on the short waves can be traced in most cases to the influence of the aerial, and the several effects commonly encountered are described in this article.

MANY newcomers to short-wave listening find great trouble in attempting full coverage, say, from 12 to 85 metres, due to the receiver failing to show any sensitivity, or else oscillating violently at one or two parts of this spectrum. The trouble is most noticeable on the "straight" type of circuit, in which the aerial is coupled to the oscillating detector circuit. A certain amount of variation is obtained by altering the length of the aerial, or the methods of coupling it, but it is usually found that the trouble can, at the best, only be shifted from one frequency to another.

Even if a complete dead spot, or a violent oscillation cannot be found, a careful comparison of signal strengths from similar types of transmissions, on various frequencies will reveal a certain amount of preferential reception at certain frequencies, which cannot always be associated with the magnification of the tuned circuits.

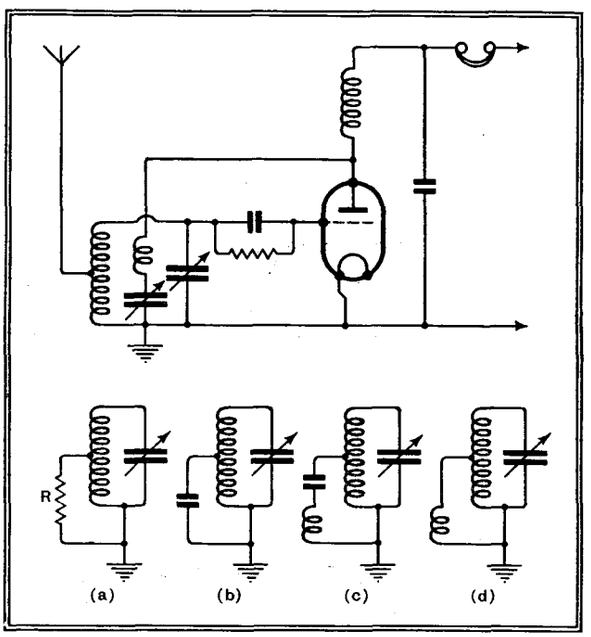
Aerial Characteristics

It is usual to suspect that the aerial system is being influenced by some neighbouring conductors, or that an inadequate earth is being employed. Such surmises are partially true, but few realise that this type of trouble is fundamentally due to the aerial, which, being no longer short compared with the wavelength, presents an ever-varying impedance to the input circuit of the receiver. The aerial may thus produce the effect of a shunt capacity, an inductance, or a pure resistance, depending upon the frequency received. As an example, an input circuit of the type shown in Fig. (1) will be examined for an aerial of about 32ft. (ten metres) length. It will be necessary to consider the characteristics of the aerial on various wavelengths first, and then derive the effect on the tuned circuit.

The aerial, free of any other apparatus, is subjected to the influence of all the signals available, and is carrying oscillatory currents of various amplitudes and frequencies. To be a perfect coupling between the ether and the set, these currents should be proportional to the signal strength at all frequencies, and, therefore, a test for verification of this property should be made.

The injection of a small voltage pulse at one end of the wire will send a current surging along to the other end with a velocity almost equal to that of light. On reaching the free end the current can flow no farther, and builds up a charge of very nearly the same amplitude as that originally injected. Subsequently a current pulse will travel back along the wire to the other end in a similar manner, and, until damped out by losses, will continue to surge to and fro, giving rise to an oscillatory current in the wire, in which the energy originally injected manifests itself as a current flowing in the central portions of the wire, with an equivalent voltage at the ends.

If a succession of voltage pulses is injected these currents and voltages will give



Typical short-wave detector showing the varying effects on the circuit at different wavelengths with a directly coupled aerial.

an additive effect, if the frequency of the pulses coincides with the frequency with which a single pulse oscillates in the wire. If the resistive and radiation losses were very low, quite enormous voltages and currents would be built up from pulses of a few microvolts at this resonant frequency.

It is found that, at frequencies corresponding to wavelengths of L., 2L., L/2, L/4, etc., where L equals the wire length in metres, the aerial behaves as a resonant circuit, which has a dynamic resistance mainly controlled by radiation losses, and on connection, as in Fig. (1), will have the same effect as in 1 (a) where R is of the order of 2,500Ω, and is strictly represented by a parallel tuned circuit of this dynamic resistance. At various intermediate wavelengths the termination of the aerial is equivalent to various arrangements of capacity and inductance, as in 1 (b), 1 (c), 1 (d), etc., until 1 (a) is again arrived at on another sub-multiple of L. It must be noted that one very troublesome arrangement is encountered when the 1 (b) conditions hold, the aerial here presenting a short-circuiting effect.

Resonance Condition

Fig. 2 has therefore been drawn for the 10-metre aerial wire under consideration, and shows the wavelengths at which such reactive effects are found at the end connected to the receiver. Above 60 metres the aerial will behave normally, and merely adds capacity to the tuned circuit, but on passing towards the shorter wavelengths, we encounter the condition 1 (c) at 40 and 15 metres; 1 (d) is encountered to a varying extent between 35 and 20 metres, and about 13 metres, while a resonant point 1 (a) appears at 20 metres, the other wavelengths being influenced by the condition represented by 1 (b).

For a longer aerial these numerous changes of impedance would occur often in the given waveband, but in the case mentioned one might expect the receiver to be extremely lively around 40 and 15 metres.

Difficulty to tune, on account of hand capacity effects, will be in evidence at about 24 and 12 metres, while reaction difficulties will occur at 20 metres. The variations of the aerial tap on the tuned circuit would only move these troublesome points to other parts of the waveband by the added inductance, or capacity, influencing the effective length of the aerial.

With a directly tapped aerial very little can be done to counteract these variations of aerial impedance with frequency, and the direct tap is really only suitable for an aerial in the 1 (a) or 1 (b) conditions.

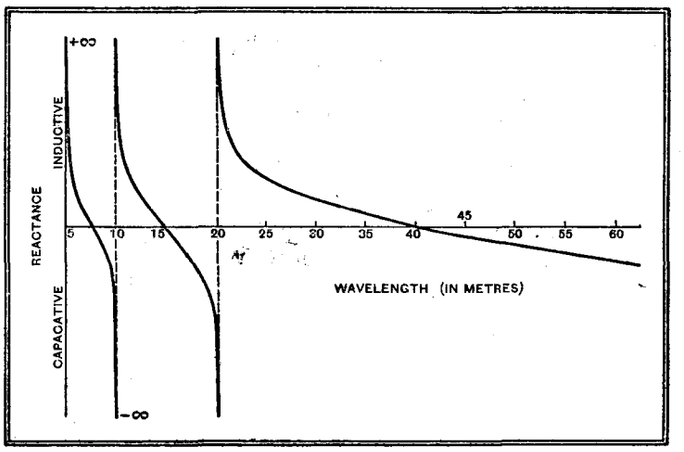
It is obvious that the short-wave aerial is only possessed of partial aperiodicity when its length is shorter than a quarter of the shortest wavelength to be received, and thus a length of nine feet is the most that can be used without expectation of trouble on the amateur bands. Such an aerial, in normal households, is bound to

Short Waves and the Amateur—

have very little efficiency in picking up signals, and, due to its proximity to buildings, etc., will also give a poor signal noise ratio.

Its best position would be high above the building, or at the top of a mast, and the problem of the lead in becomes evident, since it must obviously not act as an aerial, or the system will, on account of its effective length, return to the unwanted conditions.

It may be thought that the foregoing indicates a defeatist's viewpoint, since no practical arrangement has been suggested. This is quite true when one attempts to cover the broad frequency spectrum from, say, 10-60 metres on a single aerial, and the correct procedure is to erect an aerial which operates as a pure resistance at the centre of a desired band of frequencies (any of the amateur bands, for example).



Variations of terminal impedance of a 32-foot aerial at different parts of the short-wave band.

Suitable types of receiving aerials and their correct feeder arrangements will be described in the near future.

D.X. Notes

Some excellent telephony DX is the feature of the 20-metre band at present, which is now operative until past midnight. The Canal Zone gives very good signals in this country at about 22.00 GMT, while from 23.00 to 01.00 GMT amateurs in Brazil, Argentine, Uruguay and Ecuador are putting over very good CW and telephony. The ZL and VK signals are rapidly disappearing from the band in the morning, and will probably not be heard again with any degree of reliability until next winter. Early morning listening from 00.50 GMT should soon reward the 20-metre DX enthusiast with good signals from the North Pacific regions, coming by routes lying westward of this country, and possible reception of W6, K6, K7, J and XU should then occur.

UNBIASED

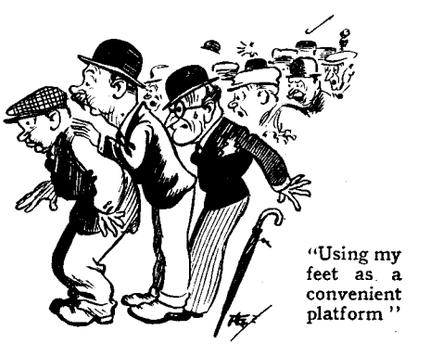
By FREE GRID

Vest-pocket Set

JUDGING by the correspondence received, readers have taken an extraordinary interest in the little note I wrote concerning listening to the commentary of the recent Jubilee procession by means of a vest-pocket headphone receiver.

They are all asking what sort of set I advise for functions of this nature. While, of course, it is now too late for the Jubilee celebrations, there are certainly heaps of functions where such a receiver is invaluable. For instance, people who actually watch such things as the Cup Final will find that listening-in to the commentary will enable them to obtain a really unbiased account of the game instead of being compelled, as I was some years ago, to accept driblets of misinformation from the oversized Yorkshireman in front of me who was using my feet as a convenient platform from which to view the game over the shoulders of a still larger fellow-citizen who was in front of him.

Apart from people able to attend these functions, however, there must be thousands whose activities compel them to be working, or engaged on some other unworthy occupation, far away both from the field of activity and from their home broadcasting receiver. In the case of this year's Final, for instance, I found myself in a 'bus during the vital moments of the



"Using my feet as a convenient platform"

game, and had it not been for my own pocket portable I should have been totally ignorant of the progress of the game.

It is, of course, quite hopeless to expect to use any other than a super-regenerative receiver for jobs of this kind. Ordinary reaction gives a range of only a few miles, while HF stages are completely ruled out owing to the necessity for keeping down the weight and bulk of batteries as far as possible. The super-regenerative circuit is, however, quite tame nowadays and totally different from the impossible sort of arrangement with which many of us mucked about in 1922.

I must confess that I am sadly surprised at the lack of enterprise shown by British manufacturers in this matter. There was an excellent little set of this type shown at Olympia last August, and my only criticism was directed at its shape. It was made like a small box camera, which made it inconvenient to carry and rather conspicuous, the latter being a fatal drawback to people of a sensitive nature like myself, who object to the rude stares of the vulgar. It should, of course, resemble a small attaché case.

Another point of criticism is headphones. I have found that the tiny earpieces with a stethoscope-like end for inserting right in the ear are simply invaluable. They are small, light, inconspicuous and successfully shut out all external sounds. They are, of course, made especially for use with various electrical deaf aids, and my only objection to them is that they are rather expensive.

Which is Standard ?

I MUST place on record my deep gratitude at the avalanche of plugs, catalogues and information with which manufacturers and readers have overwhelmed me as a result of my recent appeal for a multi-way three-pin adaptor.

Unfortunately, however, I feel in as great a difficulty as ever owing to the multiplicity of plug fittings, some of which label themselves "standard" without agreeing with others, similarly labelled, in respect either of pin diameter or spacing. Worse still, not one of the adaptors so far brought to my notice will fit the sockets which have been installed in my house by the eminent electrical engineer whom I employed for the purpose.

This coruscating jewel of the trade, when consulted on the matter, merely vouchsafed the cryptic statement that "there ain't no sich thing" and has warned me darkly against people "wot would take the likes of you in." I can only say that the articles with which this scintillating scion of Faraday has supplied me possess irregularly spaced sockets, and the earth pin, while being considerably longer than the other two, is of exactly the same diameter. With regard to those brought to my notice by readers, I notice that in some cases the earth pin is of much greater diameter than the other two, while in one case the other two are flat and not round.

What I want to know is simply this. Is there, or is there not, a recognised "standard" fitting? If there is a "standard," is the one I've had fitted in my house the true "standard," or can it be that I've been sold a pup and charged three and sixpence a time for something obtained from the sixpenny stores?

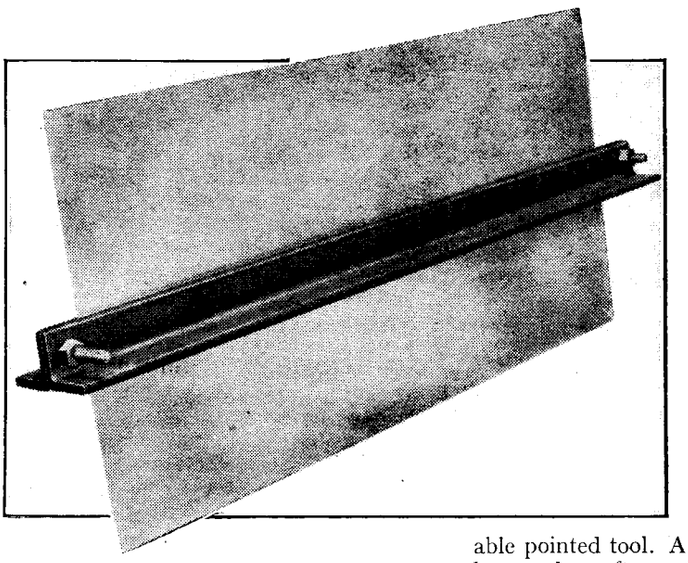
HINTS and TIPS

Practical Aids to Better Reception

IT was shown in a recent article that common sense and resourcefulness are remarkably good substitutes for measuring instruments when the need arises in an emergency for tracing a fault in a receiver.

Makeshift Voltage Indicator

In this connection it may not have occurred to many readers that a spare condenser or (even a condenser temporarily removed from the receiver) will serve as an indicator of the presence or otherwise of high-tension voltage.



A useful clamp for bending or cutting sheet metal. The pieces of angle iron of which it consists are in this case nearly 30 ins. long, but shorter lengths are generally satisfactory.

The condenser, which may have a capacity of a microfarad or so upwards, is momentarily joined across points between which HT voltage should exist, and its terminals are then short-circuited with a metal object. If everything is in order a flash will occur as the condenser is thus discharged. With a little practice, one can very roughly estimate, by the brightness of the flash and the sharpness of the resultant crackling sound, the amount of voltage applied. It is still easier to obtain by this method a rough idea of the relative voltages existing at different points.

TOOLS even remotely suited for the purpose of bending sheet metal are seldom to be found in the amateur workshop, and, unless great ingenuity and patience are exercised in devising substitutes for them, the making of metal base-plates, chassis bends, screens, etc., generally proves to be an unexpectedly difficult task.

Amateur Sheet Metal Work

But sheet metal is now so widely used that it is well worth while making the simple "bender" shown in an accompanying illustration. It costs no more than a shilling, and consists merely of two lengths of 1½in. angle iron (L-section) bolted together with a couple of set screws and nuts. The angle iron is readily obtainable from metal dealers, and it is not essential that it should be dead straight; in fact, a slight curvature (convex with regard to the two opposing faces) is an advantage rather than otherwise.

In addition to its uses for bending purposes, the tool described also serves as a vice and as an aid to cutting thinnish sheets of the softer metals. The latter operation can be carried out by clamping the sheet between the angle iron pieces and using one of the edges as a guide for scoring the metal deeply with a suitable pointed tool. A clean break can then be made, after which the edges are trimmed up with a file, again using the clamp.

IT is fairly certain that no particular type of set is basically superior to another from the point of view of minimising electrical interference. Of course, the interference *appears* to be less severe when the set is insensitive, but in all probability the ratio of unwanted noise to wanted signal will be the same for a given input.

In Disturbed Areas

The fact that certain makes of set have undoubtedly acquired a good reputation for partial immunity from electrical interference does not really disprove the truth of the foregoing statement. An investigation of the circumstances will generally show that the sets in question include a built-in mains filter which, in certain circumstances, can be extremely effective. The point is, however, that the inclusion of the type of filter normally fitted, though commendable, has nothing whatever to do with the basic design of the set; the same filter could equally well—and sometimes better—be fitted externally, say, at the point where the electric mains are brought into the building.

THE usual result of disconnecting the aerial from its terminal is to increase any tendency towards instability that may be present; indeed, in the bad old days we used to depend partly for stability on damping imposed by the aerial. On occasion, however, the reverse effect takes place, and it will be found that an otherwise unstable set is stabilised by removal of the aerial. When this happens—and fortunately it is not a common occurrence—we have a fairly certain indication that the "run" of the aerial lead-in wire should be changed, as it is probably introducing unwanted coupling between the input circuit and some other part of the wiring of the receiver.

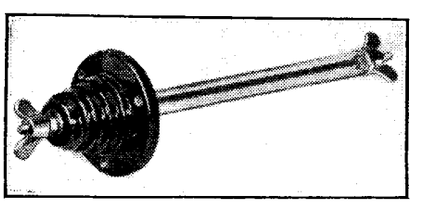
Aerial Affects Stability

The only other reasonable explanation of this effect is that the addition of the aerial brings up the input circuit roughly into tune with the succeeding HF circuits, and that the tendency towards instability thus introduced more than counterbalances the reverse effect of aerial damping—an unlikely event in practice.

IN spite of modern factory practice, in which routine testing and inspection is almost as important as actual manufacture, faulty components are still liable to be found.

Checking Components

For this reason it may be urged that even if proper testing equipment is not available, a lamp and battery or some similar improvised device for verifying the existence or non-existence of continuity should always be used. Even the crudest continuity indicator will reveal any simple fault—and the usual faults *are* simple ones—such as an open-circuited coil or a broken-down condenser. When it is realised that the presence of a short-circuited condenser may cause considerable damage to other components by imposing a short circuit across the HT supply, it will be realised that the small amount of time and trouble involved in the making of a preliminary test are not wasted.



A WEATHERPROOF LEAD-IN. This Eddystone insulator, of vitreous porcelain and glass, has been found much more satisfactory than the ordinary domestic lead-in for use under exacting conditions such as those prevailing on boats, yachts, etc.

Listeners' Guide for

(Photo: Eric J. Hosking, F.R.P.S.)

"AND THE NIGHT SHALL BE FILLED WITH MUSIC" of two kinds on Monday next, May 13th, when the B.B.C. nightingales make their 1935 debut during the dance broadcast by Sydney Kyte and the Piccadilly Hotel Dance Orchestra.

AVOIDING ANTI-CLIMAX

PERHAPS only an organisation with the splendid momentum of the B.B.C. could cope successfully with the aftermath of Jubilee week and avoid a ghastly anti-climax. It is to the credit of the Corporation that the interest of next week's programmes is well sustained, although we cannot expect, and do not get, the triumphal touch which has made the present week the most memorable in broadcasting history.

Jubilee broadcasts are not yet over, and there are three notable events on Sunday. In the morning there will be a Jubilee Thanksgiving Service relayed from St. George's Chapel, Windsor, conducted by the Dean, the Very Reverend A. V. Baillie, D.D.

THE LAST JUBILEE BROADCAST

AT 4 p.m. an open-air service of song and praise will be relayed from Hyde Park (National), where community singing will be conducted by Gibson Young from a site near Bayswater Road, half-way between Marble Arch and Cumberland Gate. The massed bands of the Coldstream and Welsh Guards will attend, led by the Ystalyfera Choir of 250 vocalists, which has won the National Eisteddfod of Wales on five separate occasions. The half-hour broadcast will include the hymns, Kipling's "Recessional," delivered by Ion Swinley, and a chorus from Mendelssohn's "Hymn of Praise," "All Men, All Things."

The last Jubilee broadcast takes the form of an address at 5 p.m. in the National programme on "Church and King," by the Rev. A. C. Deane, M.A., Canon of Windsor and Chaplain to the King.

TO-MORROW'S ROYAL BROADCASTS

THREE of the King's sons are to visit Wales, Scotland, and Northern Ireland to-morrow (Saturday) for the Jubilee celebrations, and some part of the various programmes which are being arranged will be broadcast either from the National or the local B.B.C. transmitters. The Prince of Wales will be heard in Cardiff, the Duke of York in Edinburgh, and the Duke of Gloucester in Belfast.

The Cardiff relay comprises a running commentary on the culminating feature of a week of festivity, viz., the Prince's visit to the Wales Children's Demonstration and Display at Cardiff Arms Park.

LONDON MUSIC FESTIVAL

TO-NIGHT (Friday) sees the opening of the London Music Festival with the performance of Bach's great Mass in B Minor, conducted by Adrian Boult, who, by the way, has decided to play the opening three Kyries without a break and so maintain the continuity of atmosphere which Bach intended. The soloists are Isobel Baillie (soprano), Margaret Balfour (contralto), Parry Jones (tenor), and Harold Williams (baritone).

NEW ORATORIO

THE oratorio form is not popular among modern composers, which fact adds interest to the announcement of the broadcasting from Breslau to-night (Friday) of a new oratorio, "Der Einsame" (The Lonely Man) founded on the text of Nietzsche. The programme begins at 8.10.

The author is a young and comparatively unknown Silesian composer, Hans Kraus Langer.

ECHOES OF THE PAST

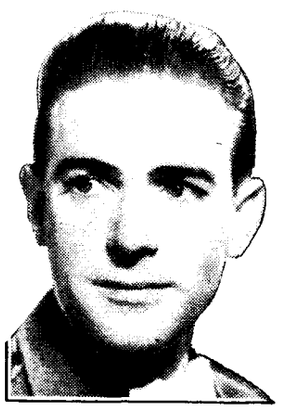
"ROYAL BOX" is the title of the special "Songs from the Shows" feature which is being broadcast this evening (Regional) and to-morrow (National). The material is drawn from those productions which the King and Queen have witnessed during the last twenty-five years.

Bertram Wallis will sing extracts from the "Count of Luxembourg," and José Collins will repeat songs from her great triumph "The Maid of the Mountains," as also will Thorpe Bates, who was in the cast of the show at the same time. Huntley Wright will be heard in songs from "The Lady of the Rose" and "Madame Pompadour," and Percy Heming in songs from "Lilac Time." Edith Day and Derek Oldham will sing numbers from "Rose Marie," and we shall also hear the famous New York star, Adèle Astaire, repeat her triumphs in "Lady, Be Good." Finally, W. H. Berry will sing his original comedy numbers from "The Marriage Market." John Watt will be *compère*.

JOAN OF ARC

JOAN OF ARC'S national fête was commemorated in France on May 8th, but the memory of the Maid of Orleans is perpetuated in the week-end programmes. To-morrow night (Saturday) at 8 Radio-Paris will broadcast "The Trial of Joan of Arc," a sketch based on historical documents, by Roger Monteaux.

On Sunday from 8.30 to 10.30 Strasbourg's commemoration programme for St. Joan will be an adaptation from Lope de Vega's "La Pulcella Francia."



CLIVE ERARD is one of "The Six of Us" who present a special variety feature at 9.45 on Monday next (Regional).

the Week

Outstanding Broadcasts at Home and Abroad

TALE OF INTRIGUE

ROSSINI was only twenty-one years of age when he composed "The Italian in Algiers," Act I of which is to be relayed from Covent Garden at 8.25 p.m. on Thursday next, May 16th, in the Regional programme.

The story is of a Barbary Coast intrigue merrily set to music, and tells how the Dey of Algiers hopes to obtain possession of pretty Isabella, found floating on a derelict ship, after disposing of his chief wife, Elvira, by marrying her to his Italian slave Lindoro, Isabella's lover. Unfortunately for the Dey, Isabella and Lindoro are enabled by the wiles of Elvira to escape from slavery while the scheming Dey's attention is distracted.

SYMPHONY CONCERTS

ELISABETH SCHUMANN, the famous operatic soprano, will be heard to-morrow evening (Saturday) at 10 o'clock in a broadcast from Milan of Beethoven's Ninth Symphony by the Vienna Philharmonic Orchestra and the Vienna State Opera Choir. Dr. Felix von Weingartner will conduct. The concert will be relayed by Vienna.

A Gustave Charpentier Festival Programme under the direction of the composer himself will be broadcast on Sunday from all the French State stations except Radio-Paris. The National Orchestra and Choir will take part. M. André Pernet, of the Paris Opera, will sing an excerpt from "Impressions fausses" (words by Verlaine), accompanied by the orchestra and a small choir, and the concert will also include the "Chant d'Apothéose." Gustave Charpentier was born in 1860, and won the Prix de Rome in 1887 with his cantata "Didon." He writes somewhat romantic, popular music, and his opera "Louise" is probably his most renowned work. The "Impressions fausses" were composed in 1895.

30-LINE TELEVISION

Baird Process Transmissions Vision 261.1 m.; Sound, 296.6 m.

MONDAY, MAY 13th.
11.15–12.0 p.m.

Hugh Miller, characters in vignette from "Bleak House"; Fiona Cunninghame, dances; Elinor Shân, mimes and dances; Gladys Merredew, character sketches and impressions. Accompaniments by Sydney Jerome.

WEDNESDAY, MAY 15th.
11.15–12.0 p.m.

"Contrasts of 1794"—a musical episode devised and produced by Eustace Robb. Maria Sandra (soprano), Gustave Ferrari (songs in French); Cleo Nordi (dances).

PLAY OF MODERN IRELAND

AN Irish play, "The Moon in the Yellow River," by Denis Johnston, will be broadcast Regionally on Tuesday next, May 14th, and Nationally on Wednesday.

The action of the play takes place on a September evening in the living-room and armoury of an old fort, now the home of Dobelle, near the mouth of an Irish river. The part of Dobelle will be taken by Esmé Percy. Blanaid, his daughter, will be represented by Anne Twig, Captain Potts by Miles Malleson, and Herr Tausch by Norman Shelley.

H.M. KING CHRISTIAN of Denmark will broadcast from Copenhagen at 3 p.m. on Tuesday next, May 14th, in opening the biggest bridge on the Continent, linking the Isle of Funen with the Jutland peninsula.

TALK BY WOMAN MINISTER

A WOMAN diplomat, Mrs. Ruth Bryan Owen, American Minister for Scandinavia, will be heard in the Kalundborg programme this evening at 7.20 in a talk on "Mothers' Day."

The American flavour will be repeated at 11 p.m., when Eli Donde's band will broadcast dance music from the "Lorry," Copenhagen. Mr. Donde is a great exponent of American jazz styles.

SHAKESPEARE PLAY AS GERMAN OPERA

SHAKESPEARE'S "Taming of the Shrew" was converted by Goetz into a popular German opera, "Der Widerspenstigen Zähmung," in 1874, and four years later it was produced in English at Drury Lane. This evening Berlin (Funkstunde) will broadcast the opera at 8.10, and listeners who heard the recent B.B.C. version of the play may wish to compare notes.

ENGLISH MUSIC IN GERMANY

TO-MORROW (Saturday) at 7 Cologne offers a concert of contemporary English Chamber Music, comprising works by Norman O'Neill, Becket Williams, and Algernon Ashton.

THE MAY REVUE

NELSON KEYS brings the May Revue to the microphone at 10.10 on Wednesday next, May 15th (National), and the cast will comprise Sylvia Leslie, Patrick Waddington, Hermione Gingold, C. Denier Warren, and the Radio Three.

These monthly revues go from strength to strength, but there is still no sign of repeat programmes, or "diagonalisation," as Colonel Dawnay would put it.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, MAY 10th.

Nat., 8.30, London Music Festival: Bach's Mass in B Minor, from Queen's Hall (B.B.C. Symphony Orchestra).
Reg., An Hour's Variety from Argyle Theatre, Birkenhead. ¶Chopin Recital by Solomon. 8.30, "From the Royal Box."
Abroad.
Munich, 7.35, Opera: "Rigoletto" (Verdi) from the National Theatre.

SATURDAY, MAY 11th.

Nat., 8, Jubilee Gala with Carroll Gibbons and the Savoy Hotel Orpheans. 10, "From the Royal Box."
Reg., American Half Hour. ¶Griller String Quartet. ¶Henry Hall's Guest Night.
Abroad.
Strasbourg, 8.30, Comic Opera: "La Basoche" (Messager).

SUNDAY, MAY 12th.

Nat., Morning Service (Jubilee Thanksgiving) from St. George's Chapel, Windsor. ¶B.B.C. Military Band, conducted by B. Walton O'Donnell; 4, Jubilee Service in Hyde Park. ¶Leslie Jeffries and Orchestra at Grand Hotel, Eastbourne.
Reg., B.B.C. Orchestra (C) conducted by Joseph Lewis. The Luton Band. ¶Psalms of Scotland, with Scottish Wireless Singers.
Abroad.
Brussels No. 1, 9, Orchestral Concert from International Exhibition.

MONDAY, MAY 13th.

Nat., Regimental Marches by B.B.C. Military Band. 8.35, "Götterdämmerung," Act II, relayed from Covent Garden.
Reg., 8, Will C. Pepper's White Coons. ¶"Willow the King"—a cricket miscellany. ¶"The Six of Us."
Abroad.
Warsaw, 9, Scandinavian Music by the Station Symphony Orchestra.

TUESDAY, MAY 14th.

Nat., "Verdi" Gramophone Programme, introduced by Francis Toye. ¶Will C. Pepper's White Coons. ¶"Freedom," by Sir Thomas Barlow, K.B.E.
Reg., Peter Haddon in "The Indiscretions of Archie." ¶B.B.C. Military Band. ¶"The Moon in the Yellow River."
Abroad.
Brussels No. 1, 8–9, 9.20–10, 10.10–11, Music from International Exhibition.

WEDNESDAY, MAY 15th.

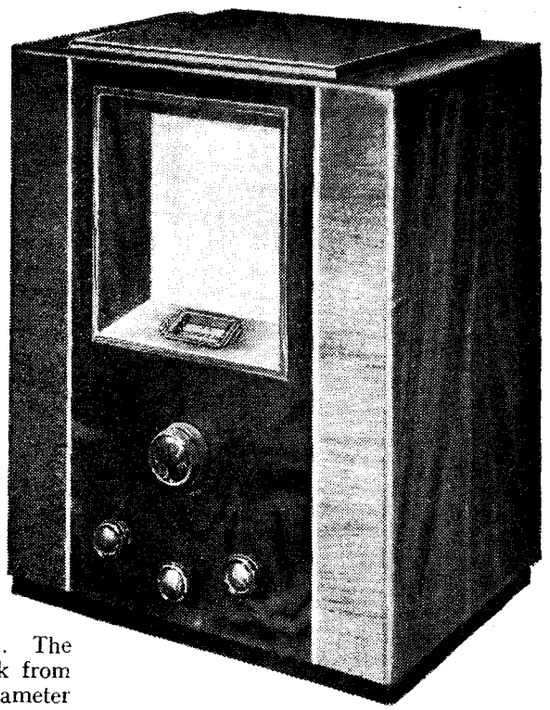
Nat., Songs of Ireland. ¶"The Moon in the Yellow River." 10.10., Nelson Keys in The May Revue.
Reg., Harold Ramsay's Rhythm Symphony.
Abroad.
Warsaw, 9, Chopin Recital by Nawrocki.

THURSDAY, MAY 16th.

Nat., 8.30, "Music Hall." ¶B.B.C. Orchestra (E) ¶B.B.C. Dance Orchestra directed by Henry Hall.
Reg., Alfredo Campoli Trio. 8.25, Act I "The Italian in Algiers" (Rossini) relayed from Covent Garden. ¶Pianoforte Recital by George Chavchavadze.
Abroad.
Konigsberg, 8.15, Variety Programme.

Climax MODEL 534

An All-wave Superheterodyne for AC Mains



FEATURES.—***Type.***—*Table-model superheterodyne for long, medium, short and ultra-short waves. AC mains operated.* ***Circuit.***—*Octode frequency-changer—var. mu pentode IF amplifier—double-diode-triode second detector—pentode output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Tone. (4) Waverange.* ***Price.***—*16 guineas.* ***Makers.***—*Climax Radio Electric Ltd., 95, Parkhill Road, Hampstead, London, N.W.3*

THERE can be no doubt that the addition of short- and ultra-short wave ranges adds considerable entertainment value to a broadcast receiver. There are now a large number of high-powered short-wave broadcast transmissions, not only on the Continent but in America, which are regularly receivable in this country, and, apart from these, the exploration of the short-wave ranges in search of new stations is itself a welcome diversion from normal broadcast listening.

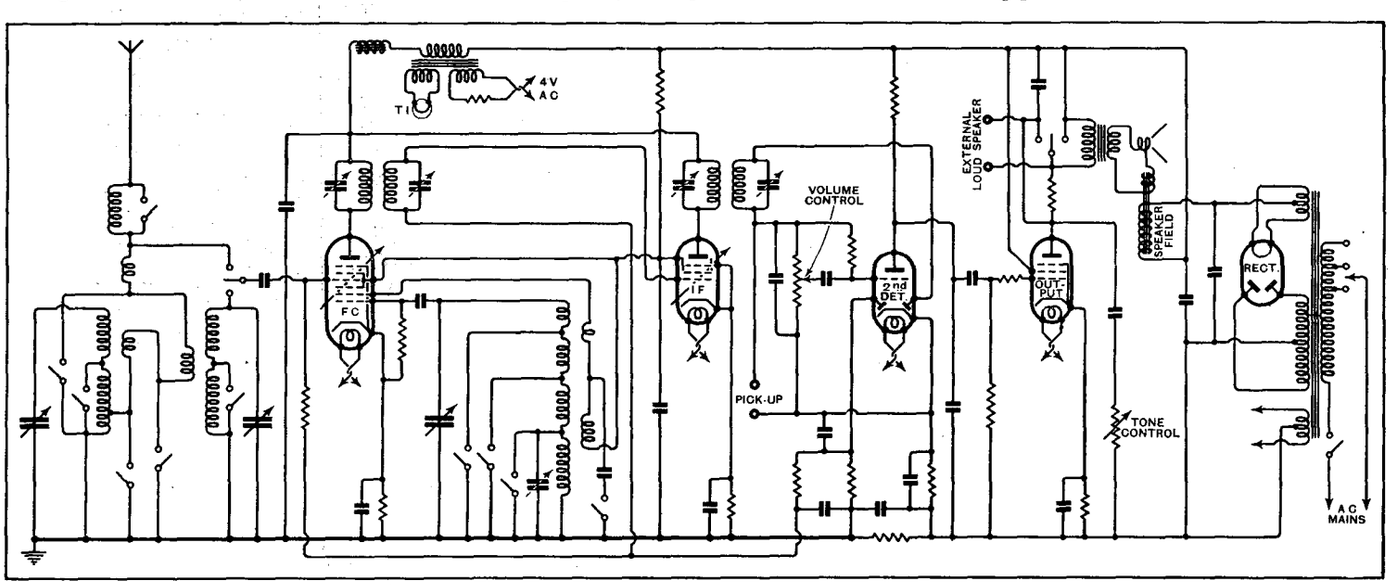
Incorporation of short-wave ranges inevitably complicates the switching arrangement and adds to the cost of manufacture, testing and adjustment, but Climax Radio have succeeded in this instrument in producing an all-wave set comparable in price with the better-class superheterodynes designed for medium- and long-wave reception only.

The design of the cabinet is interesting for the clever manner in which the open tuning scale, essential for short-wave reception, has been accommodated. The loud speaker is mounted well back from the front panel, and the large-diameter bevelled scale is viewed through a window in the lower part of the deep frame surrounding the loud-speaker fret. It is driven by a two-speed slow-motion gear with just the right ratios for short-wave and normal broadcast tuning.

Novel Tuning Indicator

The scale itself is translucent and is illuminated from behind by twin pilot lights. A third pilot lamp is suitably screened to throw a strip of light across the scale as a tuning indicator, and a special circuit has been employed to make the intensity of the light in this strip proportional to the strength of the received carrier. The lamp is fed through a small transformer from the 4-volt AC heater circuit, and a third winding on the transformer core carries the anode currents of the frequency-changer and IF valves. This current controls the saturation of the core and so influences the amount of alternating current passing through the transformer to the pilot light.

As a tribute to the sensitivity both of the set and the tuning indicator, it may be mentioned that Schenectady (19.72 metres) was tuned-in accurately during the afternoon, transmission by means of the tuning indicator alone and with the volume control at minimum. The strength of this and other American stations was unusually good, and from the programme point of view they were superior to many of the "distant" European stations working on normal wavelengths. During the period of the tests the automatic volume control was able to cope with all but a few of the deeper fading periods, and talks could be listened



Complete circuit diagram. The input circuit is aperiodic on the two short-wave bands and employs a band-pass filter with second channel suppressor on the medium- and long-wave ranges.

Climax Model 534—

to for five or ten minutes at a time without losing a single word.

A slight tendency to microphony either in the valves or the tuning condenser was noticeable with the volume control at maximum on the two short-wave ranges, but fortunately more than adequate volume was obtained without the necessity of increasing the sensitivity of the set to the point where acoustic instability commenced.

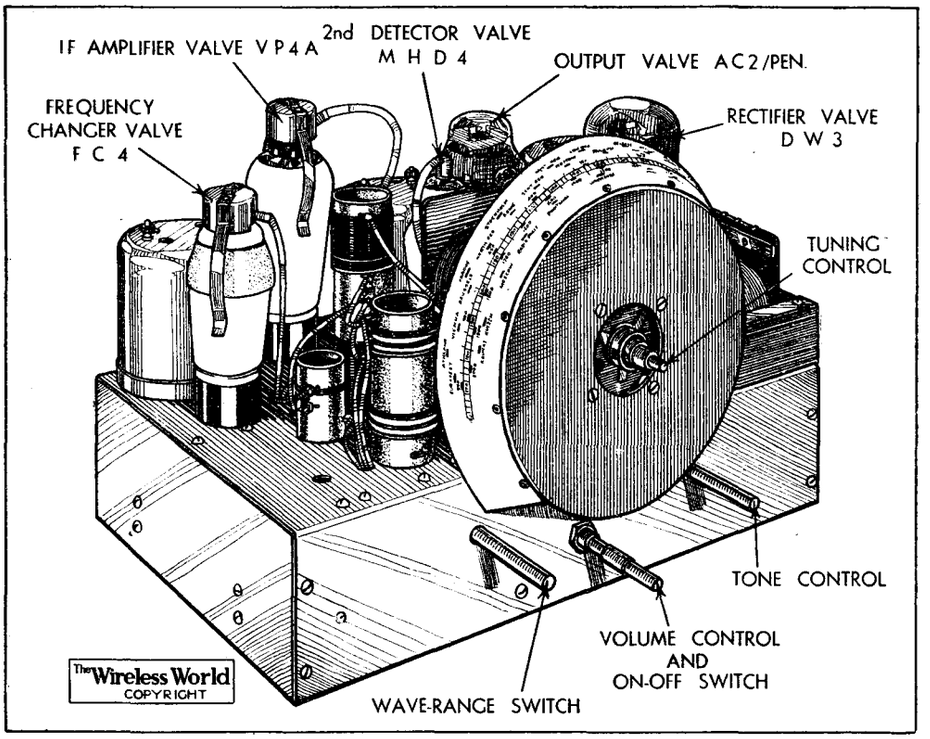
On the medium- and long-wave bands the performance both as regards range and selectivity was well above the average for a four-valve superheterodyne, and only a short aerial would be required to bring in all the European broadcasts of entertainment value. In Central London only one channel was lost on either side of the London National transmitter and a little over one channel on the Regional station. On the long waves excellent results were obtained from the Deutschlandsender between Radio-Paris and Droitwich if one were prepared to sacrifice some top response with the tone control. No self-generated whistles could be detected on the long-wave band, and there was only one very moderate second-channel whistle, due to the London Regional station, on the medium-wave range.

The circuit commences with a band-pass input filter incorporating a second-channel suppressor coupling. In series with the aerial lead is a filter coil which is open on all wavebands with the exception of the medium-wave range, and is designed to prevent break-through of the powerful medium-wave stations. Immediately below this is an aperiodic aerial coil which takes the place of the band-pass filter on short and ultra-short waves. The frequency changer, therefore, operates as an autodyne on these wavelengths, and two adjacent tuning points are obtained for each station.

Both the frequency-changer and the IF amplifier, which is of the variable-mu pentode type, are controlled by AVC derived from the double-diode-triode second detector. A delay voltage is obtained by the difference in voltages dropped across the cathode resistance of the detector valve and a resistance in series with the −HT line.

There is provision for a gramophone pick-up in the coupling to the triode amplifying portion of the second detector and the volume control operates both on radio and gramophone. The pentode output valve has a tone control circuit connected between anode and cathode, and the Magnavox energised moving-coil loud speaker may be supplemented by an external loud speaker in parallel with the primary of the output transformer. A wander-plug is provided so that one or both speakers may be used and a series resistance prevents damage to the pentode while changes are being made in the circuit.

We found nothing to criticise in the quality of reproduction, which lacked neither body of tone nor clarity. The receiver did full justice to pianoforte music and other difficult transmissions, and a very high volume level for a table model was obtained without any obvious evidence of overloading. Undoubtedly, a very wide range of entertainment value is provided in this set at a very reasonable price.


IF AMPLIFIER VALVE V P 4 A
2nd DETECTOR VALVE M H D 4
OUTPUT VALVE A C 2/PEN.
FREQUENCY CHANGER VALVE F C 4
RECTIFIER VALVE D W 3
TUNING CONTROL
TONE CONTROL
VOLUME CONTROL AND ON-OFF SWITCH
WAVE-RANGE SWITCH
The Wireless World COPYRIGHT

Outstanding features of the chassis design are the large-diameter tuning scale and the use of variable illumination as an indication of accurate tuning.

THE CATHODE RAY STREAM

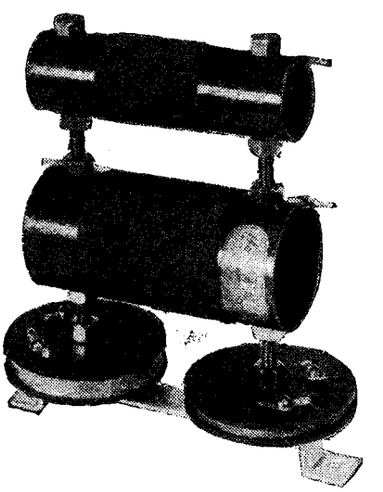
IN high-vacuum cathode ray tubes undesirable effects may be caused by the "return" flow of the electron stream after it has passed the anode and made impact with the fluorescent screen. If the electrons flow back across the space inside the bulb they are liable, for instance, to cause trouble by coming to roost on the positively charged control electrodes, or by bombarding the cathode.

One way out of the difficulty is to "trap" them on the fluorescent screen, where they can afterwards complete the journey back to the cathode through an external circuit. However, to do this the screen must be made conductive, which would not be difficult if the screen were intended to be viewed from inside the tube. But since the received picture must be visible to an observer outside the end of the glass bulb the use of an opaque metal backing is obviously impracticable.

Von Ardenne solves the problem by sputtering a monatomic layer of metal on to the transparent surface of the screen-carrier before the fluorescent material is laid on. The particles of metal are close enough together to form a conducting surface, though they are sufficiently far apart not to be opaque. Actually, the loss of light is approximately ten per cent.

The sputtering operation is carried out inside the tube by inserting a special cathode of roughly the same size and shape as the screen. It is so made that it will collapse umbrella-wise, and is only opened out after it has passed through the narrow glass neck and been advanced to within one centimetre of the screen. After sputtering, the special cathode is withdrawn, and the tube completed by mounting the usual electrodes in the ordinary way.

Coils for the Modulated Test Oscillator



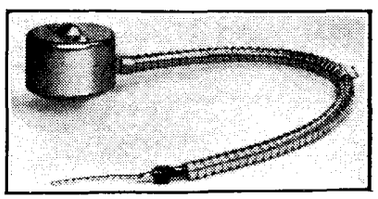
A SET of coils for *The Wireless World* Modulated Test Oscillator has been received from The British Television Supplies, Ltd., of Bush House, London, W.C.2. The four coils are wound to specification and assembled as a single unit which can be screwed directly to the baseboard. They are well finished and can be confidently recommended for use in this equipment. The price for the complete set of four coils is 10s. 6d.

New Apparatus Reviewed

Recent Products of the Manufacturers

BELLING-LEE SCREENED VALVE CONNECTOR

SCREENING of the lead to the top plug connector on HF valves is often necessary to prevent undesirable coupling, which can be a likely cause of instability in HF amplifiers. This alone does not always suffice, and the top plug on the valve as well may require screening. This is effected



Belling-Lee screened valve top connector and shielded lead.

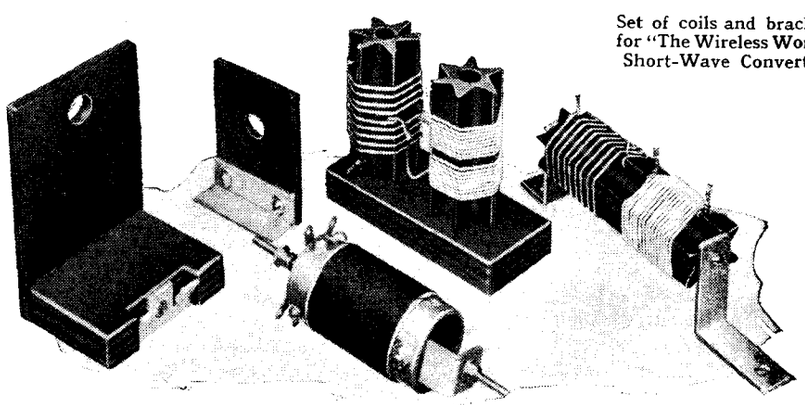
in a convenient manner by the new screened-valve top connector made by Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middlesex.

Dielectric losses are kept low by mounting the spring clip on a disc of Keramot and by the use of special beads to insulate and space the connecting lead from the screened metal sleeving. A bakelite lining in the metal hood prevents it making contact with the metallising on the valve, for this might give rise to crackles through intermittent contact. The price is 1s. 6d.

COILS FOR W.W. SHORT-WAVE CONVERTER

A SET of three coils and the two small brackets required for *The Wireless World* short-wave Converter have been sent in for examination by the Scientific Supply Stores (Wireless) Ltd., 126, Newington Causeway, London, S.E.1.

These parts are very well made and agree in every respect with the specification, for, although double silk-covered wire is used in place of the No. 20 DCC used for the



Set of coils and brackets for "The Wireless World" Short-Wave Converter.

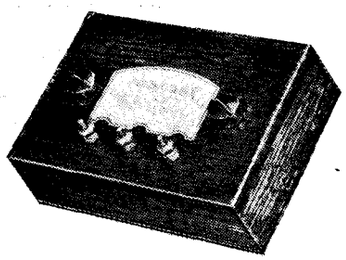
original coils, the winding occupies the same length on the former, so that the inductances are correct.

The aerial coil costs 3s., the oscillator 2s. 9d., and the HF output transformer 3s. The large bracket for the two-gang condenser costs 1s. 6d., including the small metal fixing clip for the condenser dial, and 1s. is charged for the other bracket.

FORREST DUAL-WAVE REPRESSOR

THE Dual-wave Repressor unit made by H. W. Forrest, 16, Primrose Croft, Hall Green, Birmingham, 11, is a double wave-trap with provision for partial rejection of the Droitwich and North Regional transmissions, and should be found very useful by northern listeners who experience break-through troubles from these two stations.

The rejector is most effective when attached to a receiver not embodying AVC, since this partially offsets the rejection of the signals by permitting the sensitivity of the set to increase with a reduced aerial input.



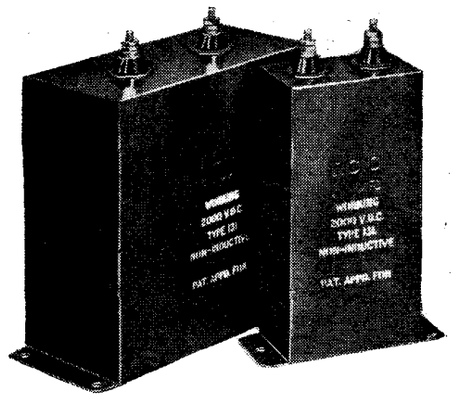
Forrest Dual-wave rejector for the Droitwich and the North Regional stations.

The unit is included in the aerial lead and does not entail any modification to the receiver, since all connections are made externally. It is small and compact, and the price is 10s. 6d.

NEW T.C.C. CONDENSERS

THE Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3, has introduced a new series of high-voltage fixed condensers in which the dielectric consists of linen-rag tissue impregnated with petroleum jelly. There is no free liquid in the container, so that leakage and creeping cannot occur.

These are made for working voltages of



One- and four-mfd. T.C.C. petroleum jelly impregnated condensers, type 131 for 2,000 volts DC working.

1,000, 1,500 and 2,000 DC, their respective type numbers being 111, 121B and 131; the latter are especially suitable for use in cathode-ray television exciter units operating at about 2,000 volts.

Each of the three types is made in sizes from 0.1 mfd. to 10 mfds., and prices range from 3s. 6d. for a 0.1-mfd. 1,000-volt type to 54s. for a 10-mfd. 2,000-volt model.

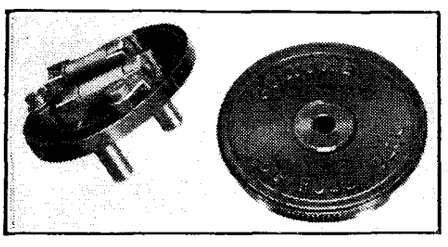
Those illustrated are a one- and a four-mfd. size for 2,000 volts DC working; the former measures $4\frac{3}{4}$in. × $2\frac{1}{2}$in. × $1\frac{1}{2}$in., whilst the dimensions of the latter are $4\frac{3}{4}$in. × $4\frac{3}{4}$in. × $2\frac{1}{2}$in., and they cost 10s. and 21s. each respectively.

Metal containers finished in the distinctive T.C.C. green are used, and the terminals are mounted on short insulating pillars.

These condensers have a very high insulation resistance, and, in addition to their particular application in television apparatus, are also especially suitable for use in LF amplifiers and wireless receivers working at high anode voltages.

GOLTONE FUSE PLUG

THE need for adequate protection of all apparatus connected to the supply mains cannot be overstressed. Several convenient fuse holders are now available for



Goltone fuse plug 2-amp. incorporating two cartridge fuses.

including in wireless apparatus and the like, and to these has now been added a new device by Ward and Goldstone, Ltd., Frederick Road (Pendleton), Manchester, 6. It consists of a 5-amp. wall plug, which is interchangeable with all standard fittings of this type, and incorporated in it are two 2-amp. cartridge-type fuses, one in each lead. They are mounted in clips for easy replacement, and the price is 1s. 4d., while extra fuses cost 4d. each.

A plug base is available at 6d., also a combined base and fuse plug in which is provided a milled-head screw, so that the plug may be fixed to the base, so preventing its accidental withdrawal. This latter fitment is especially useful for electric clocks, and its price is 1s. 10d. complete.

BROADCAST BREVITIES

By Our Special Correspondent

New Job for Variety Director

ERIC MASCHWITZ, that tireless seeker after fun for the million, will on July 1st add to his responsibilities as Variety Director the supervision of relays of outside dance bands. Hitherto this activity has been carried on by the "O.B." department, though no one within the B.B.C. seems to have been officially responsible for the actual programme material relayed from various hostelries.

Crooners De-crooned

Experience has shown that Mr. Maschwitz can never leave anything as he finds it, so we may expect some important innovations in the dance band programmes before the summer is out.

For instance, crooners, if not actually banned, may be subjected to special treatment to introduce more fundamental frequencies into their voices, and dance band leaders may be confronted with tone filters which will anglicise their announcements without attenuating their native wit and humour.

The New "O.B." Chief

A month later Mr. S. J. de Lotbinière will take over the "O.B." directorship in succession to Mr. Gerald Cock, whose appointment as Director of Television was announced recently.

Mr. Lotbinière, a member of the staff of the Talks Branch, is the biggest man between Oxford Circus and Regent's Park, for he stands 6ft. 8in. in his socks.

Sir Charles Carpendale

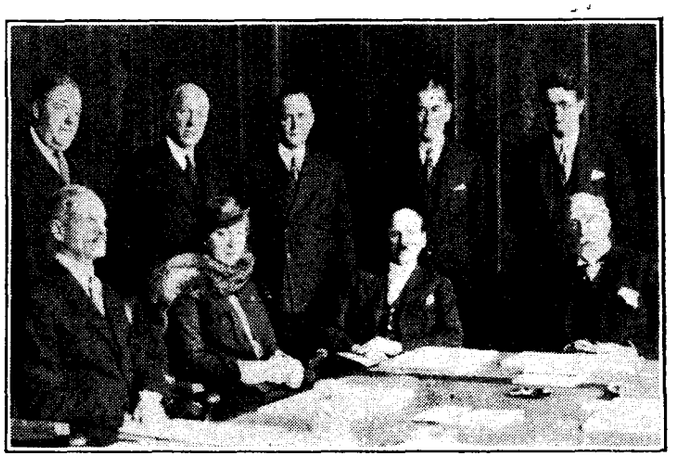
WHETHER or not Vice-Admiral Sir Charles Carpendale remains Chairman of the International Broadcasting Union, he will stay on with the B.B.C. till the expiration of the present Charter.

"Carps," as he is affectionately called at Broadcasting House, is a victim of his own machine-like organisation, for on each anniversary of his attainment of the nominal age limit of sixty the Administration Controller automatically receives an intimation that his tenure of office is now temporary!

Technical Novelties in Naval Review Broadcast

FROM a technical point of view, the most interesting "O.B." during the summer Jubilee celebrations will be the King's review of the Fleet at Spithead on July 16th, for the broadcast will involve the use of two portable transmitters.

The commentary will be given aboard the battleship "Royal Sovereign" by Commander Stride. At least four microphones will be used to pick up noises from the ships anchored in line. As the Royal Yacht steams down the line of battleships, these microphones will pick up the cheers of the crews. Listeners will be able to judge the progress of the Royal Yacht by the volume of cheering.



THE FUTURE OF BRITISH BROADCASTING. A photograph taken at the first meeting at the G.P.O. of the Committee to advise on the future of the B.B.C. Seated (left to right): Major the Hon. J. J. Astor, Lady Reading, Major C. R. Atlee, M.P., Viscount Ullswater (chairman). Standing: Mr. H. G. G. Welch (secretary), Mr. Graham White, M.P., Mr. Clement Davies, the Rt. Hon. Lord Selsdon and Lord Elton.

Boat Race Transmitter

The B.B.C. will use the Boat Race short-wave transmitter, signals from which will be picked up by an aerial erected between a lighthouse close to Southsea Castle and an obsolete military tower, and thence relayed by land line to Broadcasting House.

Two Weeks Rehearsing

To enable the engineers to check the output from the "Royal Sovereign" a small portable transmitter will be placed in position close to Southsea Castle. Thus they will be able to maintain two-way communication with the control engineer on the battleship.

In view of the many possible snags that might arise in a broadcast of this nature it is hardly surprising that the "O.B." people have decided to spend two weeks in rehearsing the event.

Trooping the Colour

There are at least three other major "O.B.'s" in the next two months. June 3rd will see the Trooping of the Colour on the King's Birthday, always a realistic item for broadcasting, for the sound effects, such as the rapid changes from quick to slow march and vice versa, and the shouting of commands help very largely to atone for the absence of the spectacular side of the event. A running commentary will be given by Major Bourne May.

R.A.F. Review

On July 6th, when the King reviews the Royal Air Force at Duxford Aerodrome, listeners will hear R.A.F. bands, 'planes leaving the ground, passing overhead, and changing engine notes as they dip for the Royal Salute.

It is hoped that a running commentary will be given by a senior officer of the R.A.F.

In the military review at Aldershot on July 13th the B.B.C. microphone will be installed beside the various saluting bases as the regiments march past.

Long Session for Charter Committee?

VISCOUNT ULLSWATER has recently paid several visits to Broadcasting House, presumably to familiarise himself with the workings of the radio machine before taking over the chairmanship of the P.M.G.'s Committee to discuss the renewal of the Corporation's Charter.

The original Crawford Committee, which first met in November, 1925, to consider the terms of the existing Charter, held sixteen meetings from that date up to February, 1926. Probably the new Committee will sit considerably longer.

They will have to ponder not only the vastly increased ramifications of the service, but the bristling problems of television and a few knotty points concerning "wireless" exchanges.

Distance Feats on Medium Waves

IF the B.B.C. medium-wave stations do not span the Atlantic, as was reported of the new Rennes-Bretagne station in last week's *Wireless World*, they are picked up regularly in Africa and the East. So many reports have come from distant listeners that the Empire Broadcasting Section has issued a list of medium-wave stations with their current wavelengths, frequencies, power, and exact location. This list has been distributed to the Empire and Colonial newspapers.

It seems likely that, with the spread of this information, there may be some startling reports in the next few months.

The Mike at Play

I HOPE that National or Regional wavelengths will not neglect the very enterprising Midland plans for the summer months. "The Microphone at Large," after visiting Ashbourne in June, will become "The Microphone at Play" and will represent various summertime pursuits and festivals. Thus the call of the river will be reflected by a visit to Evesham at Regatta time; one of the oldest of English sports—archery—by the meeting of the Woodmen of Arden at Meriden, in the very centre of England; and cricket in its happiest and most traditional form—the match on the village green.

"Jubilee Scrapbook"

"SCRAPBOOK for 1910," Leslie Baily's clever broadcast feature, has already appeared in gramophone record form, and Columbia have now followed this up with an interesting "Jubilee Scrapbook," specially written and produced by Leslie Baily and Charles Brewer.

The record (DX686) is a rapid survey of outstanding incidents from 1910 to the present, including a fanfare and proclamation of His Majesty's accession, Clarice Mayne in the first Command Performance in 1912, the voice of Lord Roberts, Florrie Forde in "Tipperary," Mr. Asquith uttering his historic ultimatum, and many other pictures in speech and song.

Foundations of Wireless

Part XXI.—Improvements on the Screen-grid Valve

By A. L. M. SOWERBY, M.Sc.

DEALING with the phenomenon of cross-modulation, to which all the earlier SG valves were prone, and explaining how modifications have been made to overcome this and other shortcomings; at the same time an almost perfect method of volume control has been incidentally provided.

WE have seen how the addition of a screen to a triode, making a screened tetrode, enables us to build high-frequency amplifiers that combine complete stability with high gain. In Fig. 111 there is given the circuit diagram of a two-stage amplifier of the type we have been discussing.

In order to prevent the detector-valve V3 from being grossly overloaded when receiving a near-by station, it will be necessary to add to this circuit some form of "volume control" by manipulation of which the overall gain of the amplifier can be adjusted. By this means it is possible to ensure that the signal-voltage reaching the detector is kept at a constant value irrespective of the voltage produced at the aerial by the particular transmitter tuned in.

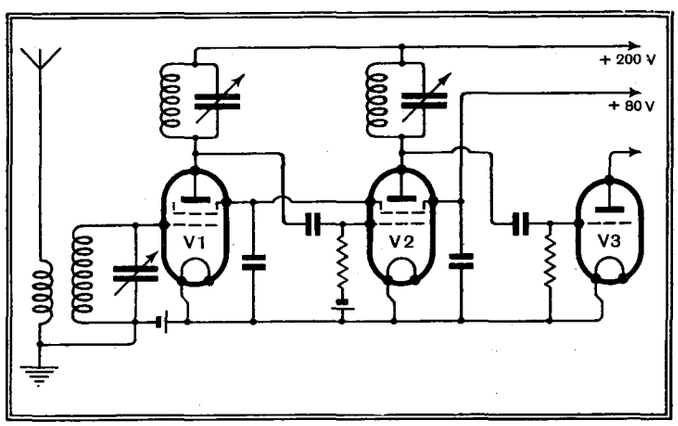


Fig. 111.—Two-stage high-frequency amplifier, using tuned-anode circuit with screen grid valves.

Volume control can be obtained in the three general ways illustrated in Fig. 112; by controlling the input from the aerial, as at (*a*), by controlling the magnification of one or more tuned circuits, as at (*b*), or by controlling the gain given by the valve, as at (*c*). Method (*a*) offers the considerable advantage that the amplifier is always working under the same conditions (so far at least as the desired station is concerned) but is seldom used owing to practical difficulties. Of these not the least is due to the production of a certain amount of background noise ("valve hiss") in the amplifier itself. Normally, amplifier noise is trifling compared with noise picked up by the aerial, and is practically never heard if the gain of the amplifier is reduced when receiving signals powerful enough to drown extraneous noise. But with any volume-control of the type of Fig. 112 (*a*) the amplifier works always at full gain, and self-generated noise becomes noticeable on all the stronger stations. For this reason method (*a*) is not used save as an auxiliary to some other type of control.

Method (*b*) suffers from the drawback that in reducing the gain of a tuned circuit its selectivity is reduced also; save for local-station reception, where this is sometimes considered an advantage, this type of control is not used.

Method (*c*) is, theoretically, ideal, since it supplies a means of controlling gain without affecting any of the other characteristics of the amplifier. In the particular form shown in the diagram, however, it leaves a good deal to be desired, as can be seen by reference to the curves of Fig. 113.

Here are shown the $Eg - Ia$ curves of a typical screen-grid valve, and it is at once evident that when the voltage on the screen is lowered the available portion of the characteristic, lying between the grid-current region and cut-off, is neither long enough nor straight enough to accommodate a signal of any but very small magnitude. As always, a curved characteristic means rectification, with its accompanying distortion, and it is clear that with such a volume control as this distortion will be greatest where we can least tolerate it—when receiving the local station.

If the valve were dealing with a simple unmodulated carrier distortion would be harmless, for distortion of a simple waveform means no more than that there are added to it various harmonics. Since subsequent tuned circuits, tuned to the fundamental frequency, would not respond to these, they could never reach the detector-valve, and so no harm would be done.

Spurious Frequencies Introduced

Unfortunately, our valve has to deal with a modulated wave; in other words, with a whole spectrum of closely-related frequencies. Distortion of such a complex signal results in complexity worse confounded, since a number of new frequencies, derived from those of the signal, are manufactured in the valve. The net result is a rise in the depth of modulation, together with the importation into the signal of new sidebands which are removed from the carrier two and three times as far in frequency as the original sidebands from which the valve produced them. At the detector, these appear as harmonics of the note originally transmitted.

Besides this distortion of a single modulated carrier there is a type of distortion, known as *cross-modulation*, which makes its appearance under the misleading guise of lack of selectivity. It arises like this.

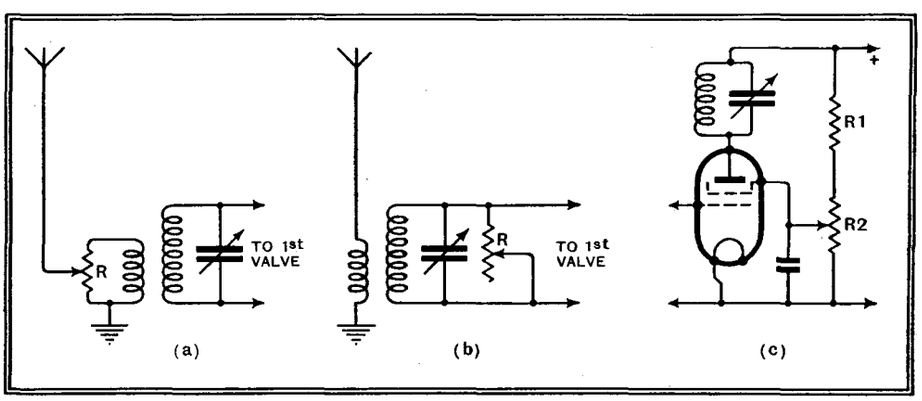


Fig. 112.—Three general methods of controlling the signal passed to V3 in Fig. 111.

Foundations of Wireless—

Suppose that the receiver of Fig. 111 is tuned to a station 45 kc/s away from the local. We may very well assume that the overall selectivity of the three tuned circuits is enough to reduce the local station to inaudibility when they are all tuned 45

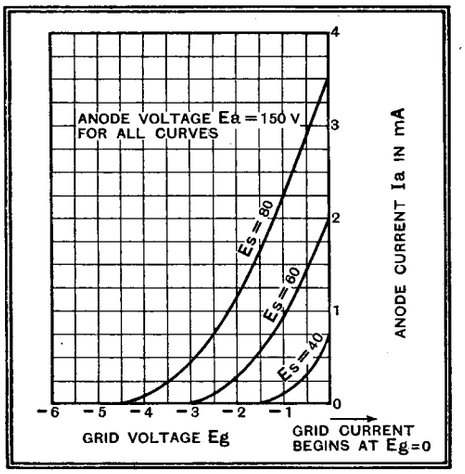


Fig. 113.—Curves of ordinary screen-grid valve. Note that rectification (overload) can occur on quite a small signal, especially when Es is reduced.

kc/s away from it. But the grid of the first valve is only protected from the local station by one single tuned circuit; it is not impossible that at this grid this station may produce quite a large voltage. If this voltage is large enough to cause the valve to rectify, one family of the resultant valve-produced frequencies consists of the carrier of the station to which the set is tuned modulated with the programme of the local station. Since the set is tuned to this carrier, the remaining two tuned circuits will pass it along, together with its twin programmes, to the detector, which will make both stations audible together. If the station to which the set is tuned switches off its carrier wave the programme of the local station will also disappear, thereby proving beyond all doubt that the interference is due to cross-modulation, and not simply to lack of selectivity in the tuned circuits.

Ineffective Tuned Circuits

For all practical purposes, the selectivity of a set in which cross-modulation is occurring is no greater than that of the tuned circuit preceding the first grid. For that reason, it is common practice to interpose two tuned circuits between the aerial and the first valve.

For more satisfactory prevention of cross-modulation we shall have to replace the first valve with one which overloads less readily, so that quite large voltages from the local station can reach it without causing rectification. Further, this new valve must be suited to some means of gain-control other than that obtainable by reduction of screen voltage, which must inevitably reduce the signal-acceptance of the valve.

To fulfil these conditions the variable-mu screen grid valve has been produced. It differs from the normal screen grid valve only in having a control-grid with a mesh of uneven pitch. Where the mesh is close it behaves as an ordinary screened valve of high amplification factor; where it is open, the flying electrons are controlled as in a low-mu valve, and a large negative bias is consequently required to reduce the anode current to zero. The valve behaves as, and in effect actually is, two valves in parallel.

In Fig. 114 is plotted the $Eg - Ia$ curve of a variable-mu valve, the curve of an ordinary screen grid valve being plotted, for comparison, on the same diagram. As the curve at once shows, the high-mu component of the variable-mu valve is effective at low bias values, while at high bias the low-mu portion alone is in operation, since the electrons are unable to penetrate the close-mesh portion of the grid when this is very negative.

The value of this valve does not only lie in the fact that it has a characteristic long enough to accommodate a very strong signal without serious distortion; in addition, the change of amplification factor with bias allows us to use bias variations as a means of controlling amplification.

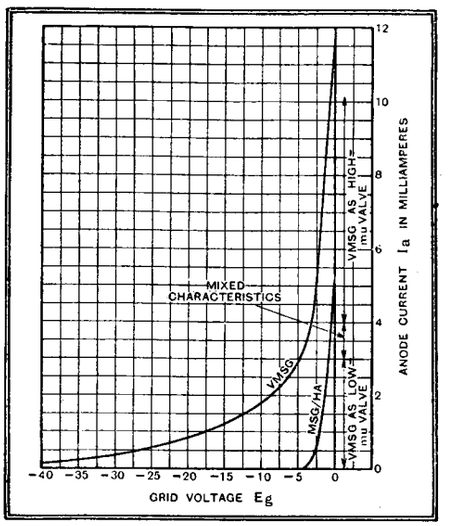


Fig. 114.—Characteristic of variable-mu valve (VMSG) compared with that of standard screen-grid valve. Note the increased signal-handling ability of the VMSG and the slow but steady change of slope with bias.

We have already seen that the gain given by a screened valve is approximately proportional to the slope; Fig. 115 shows how this varies with applied bias, and makes clear how, by increasing the bias, the gain of the stage can be reduced to almost any desired extent.

The curve (Fig. 114) is still not straight, so that distortion, modulation-rise, and cross-modulation are still theoretically possible. In practice, their appearance when using a variable-mu valve is a rarity, because it is extremely seldom that a received signal is strong enough to sweep the grid over more than a very small portion of its characteristic—and over any very small range this curve, or any other, may be regarded as substantially straight. And it must be remembered that for strong signals the bias is increased—primarily for the sake of reducing gain, but incidentally providing a working point suited to a strong signal.

As a result of these advantages over the simple screen-grid valve, the latter has been almost entirely ousted by its newer rival. In no other respect than those just touched upon is there any difference between the two types of valve; with the obvious minor modifications, all that was said in Part XIX about the simpler valve may be applied, without alteration, to its successor.

Secondary Emission

While the introduction of variable-mu characteristics overcomes with fair completeness overloading and distortion arising in the grid circuit of the valve, there remain possibilities of trouble in the anode circuit. These arise owing to the peculiar shape of the $Ea - Ia$ curve, which is shown in full line in Fig. 116. If, as described in Part XIX, the sole effect of raising the anode voltage were to rob the screen of more and more electrons, the valve curves would take a form such as that shown dotted on the same diagram. Why the divergence between theory and observed fact?

As always when theory and practice do not agree, the theory has overlooked something. In the present case it has omitted to take into account the phenomenon of *secondary emission*, by which is meant the ability of a fast-moving electron to knock out another electron when it strikes a metal surface. Once liberated, free electrons so produced will naturally be attracted to the most positively charged object in their neighbourhood.

At low anode voltages the real curve follows the dotted one, but at A the velocity of the electrons has risen enough to enable them to dislodge secondary electrons from the anode on their arrival there. These electrons find their way to the more positive screen, so reducing the net number of electrons arriving at the anode, and reducing the anode current below the "theoretical" value. Beyond B, the peak of the curve, each extra electron drawn to the anode by rising voltage knocks out more than one when it gets there, and these all reach the screen, which still has

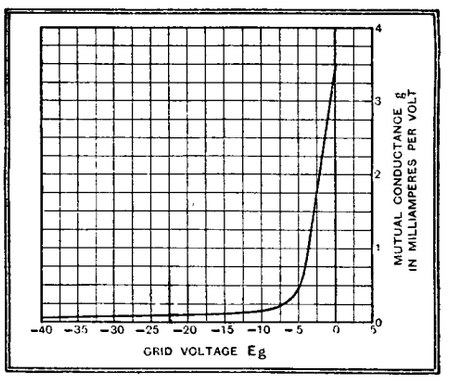


Fig. 115.—How the mutual conductance of a variable-mu valve (VMSG) is affected by alterations of bias.

Foundations of Wireless—

the higher potential. The current, therefore, *decreases* with rising anode voltage. It even reverses in direction, this merely meaning that the number of electrons arriving at the anode is less than the number they dislodge by secondary emission.

At higher anode voltages than that at C, the secondary electrons begin, in creasing numbers, to return to the anode, allowing the anode current, therefore, to begin to return towards its "theoretical" value. Finally, as soon as E*a* exceeds E*s* by a small amount (at D) the superior attraction of the anode prevents any from reaching the screen. The observed curve has now joined the dotted curve, showing that secondary emission no longer has any effect on the net anode current.

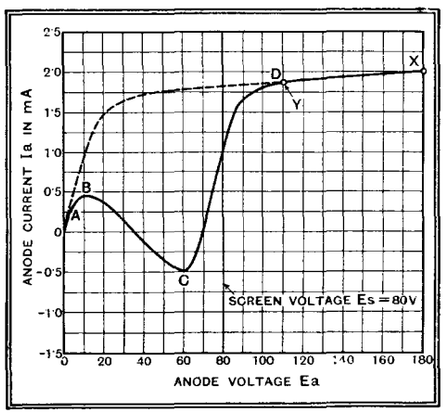


Fig. 116.—"Theoretical" (dotted) and actual (full line) curves of tetrode valve. The extraordinary shape of the latter between A and D is due to secondary emission from the anode. The introduction of a "suppressor" grid, turning the valve into a pentode, enables the dotted curve to be realised in an actual valve.

Secondary emission, although it must occur, does not distort the characteristic curves of a triode valve, for the excellent reason that secondary electrons, when emitted, always return to the anode, since it is the only positively charged object near them. The total anode current is thus not altered by their temporary absence from the anode.

Consideration of the full-line curves in Fig. 116 makes it perfectly clear that if the voltage at the anode is swung by the signal so far that it falls momentarily down to that of the screen, violent distortion is likely to occur. If, for example, E*a* = 180V. and E*s* = 80V., the maximum permissible signal swing at the anode is about 70 volts peak (from X down to Y; after that, rapid curvature begins).

Admittedly, signal voltages of this order are seldom required in a high-frequency stage, so that distortion of this type does not often occur. Nevertheless, its source can be removed by inserting between screen and anode an extra grid, connected to cathode, which will serve to protect the electrons dislodged from the anode from the attraction of the screen, so ensuring that, as in the case of the triode, they all return to the anode. This extra grid is called a *suppressor grid* by virtue of the fact that it "suppresses" secondary emission, and a valve containing it, having five electrodes, is known as a *pentode*. The shape of the E*a* – I*a* curves of the pentode is, as theory predicts, practically that of the dotted curve of Fig. 116.

Like the screened tetrode, the screened pentode is available in both variable-mu and "straight" types; the former is intended primarily for amplification, while the latter makes a serviceable detector or low-frequency amplifier. The addition of the suppressor still further reduces the influence of the anode in determining the total space-current through the valve; in other words, the pentode has a higher AC resistance (and consequently a higher amplification factor) than a corresponding tetrode of the same slope. Since, in a high-frequency amplifier, the valve is shunted across the tuned circuit (as in Fig. 111), this high AC resistance results in a slight gain in selectivity as compared with the tetrode; save for this one point, and the total elimination of the possibility of anode-circuit overload through running the anode to a voltage less than that of the screen, the screened pentode and the screened tetrode may be regarded as identical. Except when overloading is possible, no difference whatever will be found, in practical use in a receiver, between the two valves.

To sum up, we may quite safely regard the variable-mu screened tetrode, and the variable-mu and straight screened pentode, as being no more than ordinary screened tetrodes from which certain faults have been eliminated. They require no special theoretical treatment, since all important points have been covered already in discussing the triode (Parts XII and XIII) and the simple tetrode (Part XIX.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

The Cardiograph

AFTER reading the article in your paper on the Cathode Ray Electrocardiograph I feel that, in fairness to the makers of what I believe was the first portable electrocardiograph, I must write and tell you of my experiences with one of their instruments.

The instrument uses a string galvanometer, and is made by the Cambridge Scientific Instrument Company. It is quite definitely portable, and has been taken to many odd corners of England, and has flown to the Channel Islands.

My colleague and I have, during the last four years, visited about five hundred patients and taken over a thousand records of the three Einthoven leads. During this time we have neither of us had any serious trouble, and, although the fibre is certainly fine (it cannot be seen by the naked eye), we are still using the original one, despite the fact that the instrument has travelled several hundred miles in London taxis and is always left to the tender mercies of porters on its railway journeys. Now, this does not sound like a delicate instrument, and when one considers that a valve amplifier in a commercial wireless set is lucky if it does not go back to the works after about three months, one wonders whether a cathode-ray instrument would be as reliable.

The delay in seeing the result is not very serious, as even at the bedside we can have a photograph ready to look at within ten minutes of taking it, and there is then the very real advantage of being able to compare the three leads.

Although the cathode-ray tube may have a low inertia compared with the string galvanometer, there seems little point in using this in conjunction with an amplifier having a "high note" cut-off of 30 cycles per sec.

Finally, the Cambridge instrument simultaneously registers voltage and time markings which are a great help in reading the cardiogram. Furthermore, it gives a negative from which prints with a black line on a white ground can be made directly; this is very useful where there are two or three doctors in consultation who all want copies. With the Cossor-Robertson instrument it would appear that no time or voltage marks are recorded, and that ordinary development of the film would give a "negative" print (i.e., white on black), which is not so pleasing to look at or so easy to read.

I have, of course, no interest in the Cambridge Scientific Instrument Company.

ROBERT J. PARRIS.

London, S.E.11.

"The Moon and Wireless"

IN *The Wireless World* of March 22nd, under the heading of "The Moon and Wireless," your contributor "Diallist" makes statements regarding my work that are unfortunately somewhat misleading. The position is as follows: The moon does cause regular tides to occur in the atmosphere; this was not discovered by myself, though I have studied the phenomenon more extensively than any earlier worker. The tides have an interesting *bearing* on the condition of the reflecting layers that play such an important part in wireless transmission and reception, but I do not think there is any warrant for saying that they have a "marked *effect*" on that condition. The tidal movements do give rise to electrical changes high up in the atmosphere, and to observable magnetic changes near the earth's surface. The observation of these magnetic changes thus throws light on the conditions in the reflecting layers. The changes, both magnetic and electric, are in themselves very small, and I doubt whether they have any important influence on radio transmission. In particular, the tidal movement is a half-daily phenomenon, and is the same at new moon as at full moon, though certainly the electrical changes which it produces in the reflecting layers are not the same for all phases of the moon. I doubt whether the change in the phase of the moon can appreciably affect reception conditions.

You will see that the sense of the above is that the lunar tide, while of great theoretical interest for radio workers, is not likely to be of direct practical importance.

S. CHAPMAN.

Imperial College of Science and Technology, London, S.W.7.

The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	481
Modulated Test Oscillator	482
HF Chokes: Construction and Performance	486
Current Topics	489
Five-Metre Super-Regenerator	490
Unbiased	492
The Gordon Magnesium Battery	493
Single Side-band Broadcasting	495
H.M.V. Universal Superheterodyne	496
Listeners' Guide for the Week	498
Readers' Problems	500
Broadcast Brevities	501
Letters to the Editor	502
Random Radiations	502
Foundations of Wireless XXII	504

EDITORIAL COMMENT

Short Wave Broadcasts

The Importance of Clear Channels

A GREAT many letters have reached us during past months, mostly from readers abroad, complaining of the amount of morse interference which they receive when listening to the Empire or other short wave broadcast transmissions. The increase in the number of these complaints is probably due mainly to the growing interest in short wave listening, but it is probably also accounted for to some extent by an increase in the number of telegraph transmitters using the short waves.

An unsatisfactory aspect of these complaints is that in hardly any instances do they attempt to identify the morse transmissions causing interference. Until the stations originating the trouble are identified by listeners it is difficult, if not impossible, to hazard a guess as to whether or not they are guilty or innocent parties.

Clear Bands Allotted to S.W. Broadcasts

First let us remember that groups of clear bands have been allotted by international agreement in about five places in the short wave spectrum to broadcasting, and practically all the short wave broadcasting stations of the world adhere strictly to the allotted wavelengths. So that if it could be shown that morse stations are transmitting in these bands their identification would probably lead to prompt instructions to them to get off.

But there are other possible explanations for these interferences. The increase in the number of stations on short waves and the fact that many short wave receivers now in use are of obsolete design means that second channel interference is likely to be much more prevalent than formerly, and we cannot help thinking that much of the trouble complained of by listeners is to be found in their own sets.

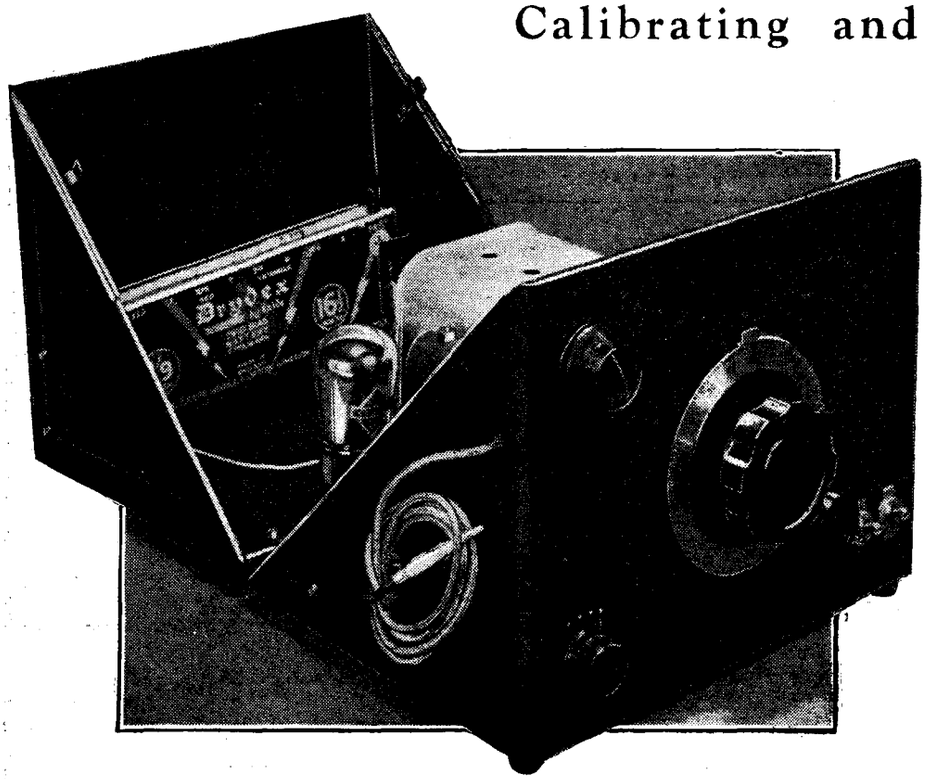
Speculation

Another interesting possibility which has not, we believe, been very fully investigated so far is that some of this interference may be caused by harmonics of transmitters which, on their fundamental wavelengths, are working in their allotted frequency bands. If listeners would make a point of trying to identify the interfering stations it would go a long way towards discovering whether harmonic interference is taking place. It would seem possible that stations on a higher wavelength communicating over comparatively short distances might be causing interference much further afield by harmonics which, on a shorter wavelength, might be travelling great distances. But in the absence of evidence this is, of course, mere speculation.

Whatever the cause of this increasing interference on short waves may be, we would urge our readers to endeavour to identify the stations wherever possible, and we would welcome reports from listeners giving the call-signs of such transmitters with the precise wavelength on which the interference came in and details of the receiver used. It is very desirable, with the growing importance of short waves for broadcasting purposes and the fact that their range is practically world-wide, that every possible effort should be made to keep these channels clear of every other kind of transmission.

Modulated Test Oscillator

Calibrating and Using the Equipment



Concluded from page 460 of last week's issue

THE constructional details of the oscillator have already appeared in "The Wireless World," and some notes are given in this article on the more common uses of the apparatus. Not only is a method of calibration described for where a wavemeter is available, but also one which suits the more general case where broadcasting stations must be relied upon as a source of known frequency.

BEFORE the oscillator can be put to wide use it must be calibrated, for although the published curves for the original model will hold approximately for any other which is constructed exactly to specification they are of no use for any but rough testing. The first step is to make sure that both oscillators are functioning and the low-frequency oscillator can be checked by inserting a pair of telephones in series with the HT battery. Upon closing S2 and S3 a note of some 800 c/s should be heard. If it is not, check over the connections of the LF oscillator, make sure that the batteries are giving their full voltages and try interchanging the valves.

When operation has been secured replace the telephones by a low-range milliammeter and open S2. Only the HF oscillator will be operative and the meter should show a reading of about 0.6 mA. If the valve is oscillating there will be a change of current—usually a rise—on touching the grid terminal of the valve-holder with a wet finger. Do not be content with a test at a single point, but repeat the process at half a dozen points on each range. When the valve is oscillating the anode current will probably change somewhat as the tuning control is rotated, and this indicates nothing abnormal, for it means merely that the amplitude of oscillation is varying, due to changes in the characteristics of the tuned circuit.

The calibration is most easily carried out with the aid of another oscillator which is already calibrated The best connections for this are shown in Fig. 1. Any convenient valve is connected as a diode detector and fed as shown from the test oscillator and from the calibrated oscillator *via* a small coupling coil which can usually have about two turns. When the two oscillators are adjusted to have nearly the same frequency a whistle will be heard in the phones, and the pitch of this will vary with the setting of the oscillator control. The coupling to the calibrated oscillator should be as weak as possible, consistent with a clearly audible whistle, and the output control on the oscillator being calibrated should be about half-way between minimum and maximum.

If the tuning control be rotated over a wide range it is possible that more than one whistle will be found, due to beats formed between the different harmonics of the two oscillators. The required beat between the two fundamentals is so much stronger than the others, however, that no difficulty should be experienced in picking it out. If the couplings be then adjusted so that it is quite weak the others are likely to be inaudible, and no confusion can possibly arise.

During calibration the oscillator case should, of course, be closed, and the case earthed, while S2 should be open. Once R1 is set it should not be altered again until the whole calibration is finished. Set S1 to the appropriate range and the calibrated oscillator to a definite frequency, such as 100 kc/s for range 4; then rotate the dial of the oscillator being calibrated until the beat note is heard. As the dial is turned the pitch of the whistle will fall and then disappear. A further rotation of the dial in the same direction will cause the whistle to appear again, and it will this time rise in pitch. The silent point occurs when both oscillators have the same frequency, so that the process of calibration consists merely of noting a number of dial readings for each range corresponding to the silent points for known frequencies on the calibrated oscillators. Some six to ten points should be taken for each range and then plotted, and the calibration curve drawn through them.

This is the simplest method of calibration, but it is only possible when a calibrated oscillator is available. It is, therefore, fortunate that it is by no means difficult to calibrate the apparatus by means of broadcasting stations, provided that a

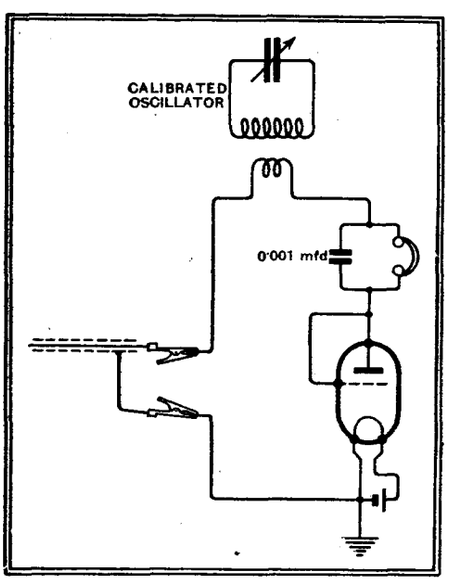


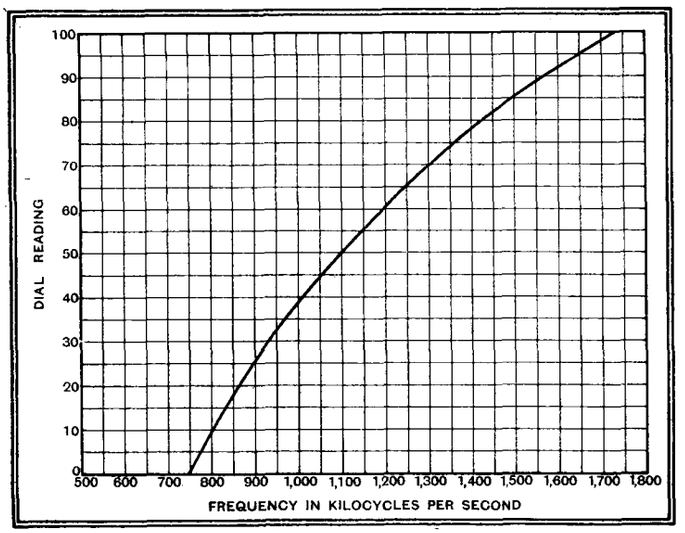
Fig. 1.—The connections employed when a heterodyne wavemeter is available for calibration. The output of the test oscillator is shown by the crocodile clips.

Modulated Test Oscillator—

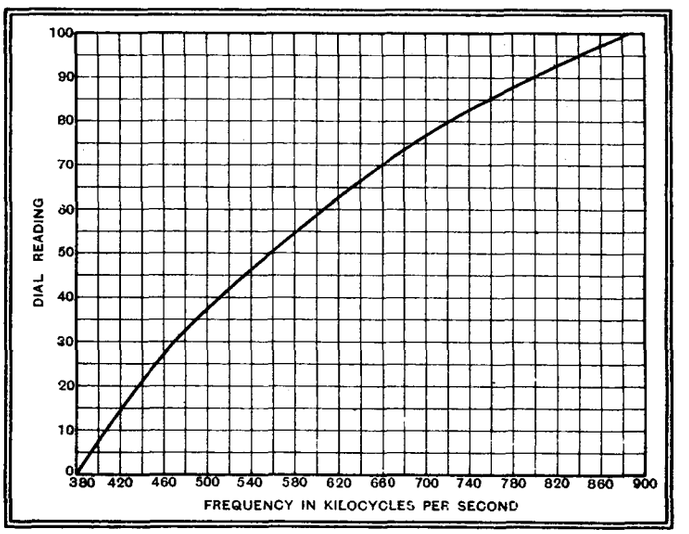
receiver is available which will receive a good number of stations. The oscillator output leads should be connected in the aerial circuit of the receiver, the screening being taken to the aerial terminal of the set and the aerial itself to the other lead. Switch off the oscillator and tune in a known station, such as Brussels No. 1 on 620 kc/s. Set S1 to range 2, switch on by S3 and rotate the oscillator dial until the beat note is heard and tune to the silent point, keeping the output control at a fairly low setting. Note the dial reading, switch off the oscillator, and find another station within the range of the coil in use, and repeat the process. Take as many points as possible for each range in this way, plot them and draw the calibration curves. It will probably be found that these do not pass through all the points, but if only two or three out of every ten or twelve points lie off the curves they can be ignored, for their positions are probably in error, due to inaccuracies of setting the oscillator and reading the dial, and to variations in the frequencies of the broadcasting stations themselves.

The complete curves cannot be drawn in this manner, for the oscillator covers a wider range than the bands assigned to broadcasting stations. By making use of harmonics, however, it is by no means difficult to obtain an accurate calibration over the whole range. Thus, on range 4, two points at least can be obtained directly by tuning in Huizen and Radio-Paris. The full range is from 93 kc/s to 187 kc/s, and these stations enable direct calibration over the band of 160-187 kc/s to be obtained. The gap of 93-160 kc/s is very important, as most superheterodyne intermediate frequencies lie within it. Calibration can readily be secured with the aid of second harmonics of the oscillator. The procedure is to tune in Droitwich on 200 kc/s and heterodyne it with the oscillator, the fundamental frequency setting for which will be found on range 3 of the oscillator. Then increase the setting of the oscillator dial until a second point is found at which the familiar whistle is heard. Tune to the silent point as before and note the reading. The oscillator is now working at a frequency exactly one-half of that to which the receiver is tuned, or, in this case, 100 kc/s. By heterodyning in this way stations in the band 186-320 kc/s the fundamental range of 93-160 kc/s on the oscillator can be calibrated. It is as well in every case to start with the fundamental of the oscillator heterodyning the transmission, and slowly to reduce the frequency until the second whistle be found, for there can then be no confusion with higher harmonics. Thus, if a station on 355 kc/s were used a whistle will be found with the oscillator at this frequency, or when it is at 177.5 kc/s through the second harmonic. A whistle will also be heard at 118.3 kc/s, however, due to the third harmonic, and if this point were to be mistaken for the second harmonic setting serious errors in calibration would inevitably result.

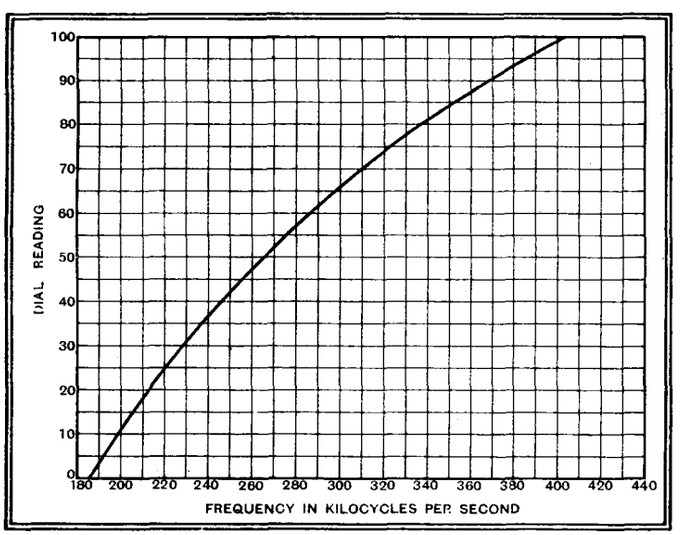
Fortunately errors of this nature will be found immediately when the calibration curve is plotted, for a mistake in the degree of the harmonic will cause the point to lie very widely off the curve. It should be noted that the whistle obtained from a second harmonic is weaker than that from a fundamental, so that before the calibration is started, the output from the oscilla-



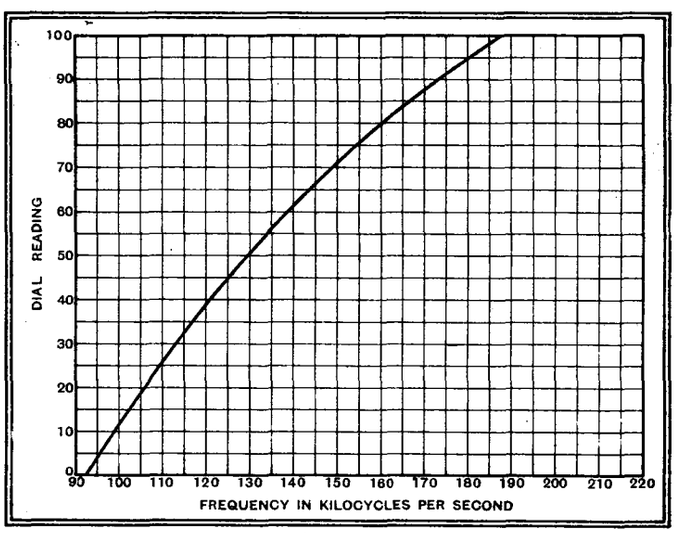
RANGE I.



RANGE II.



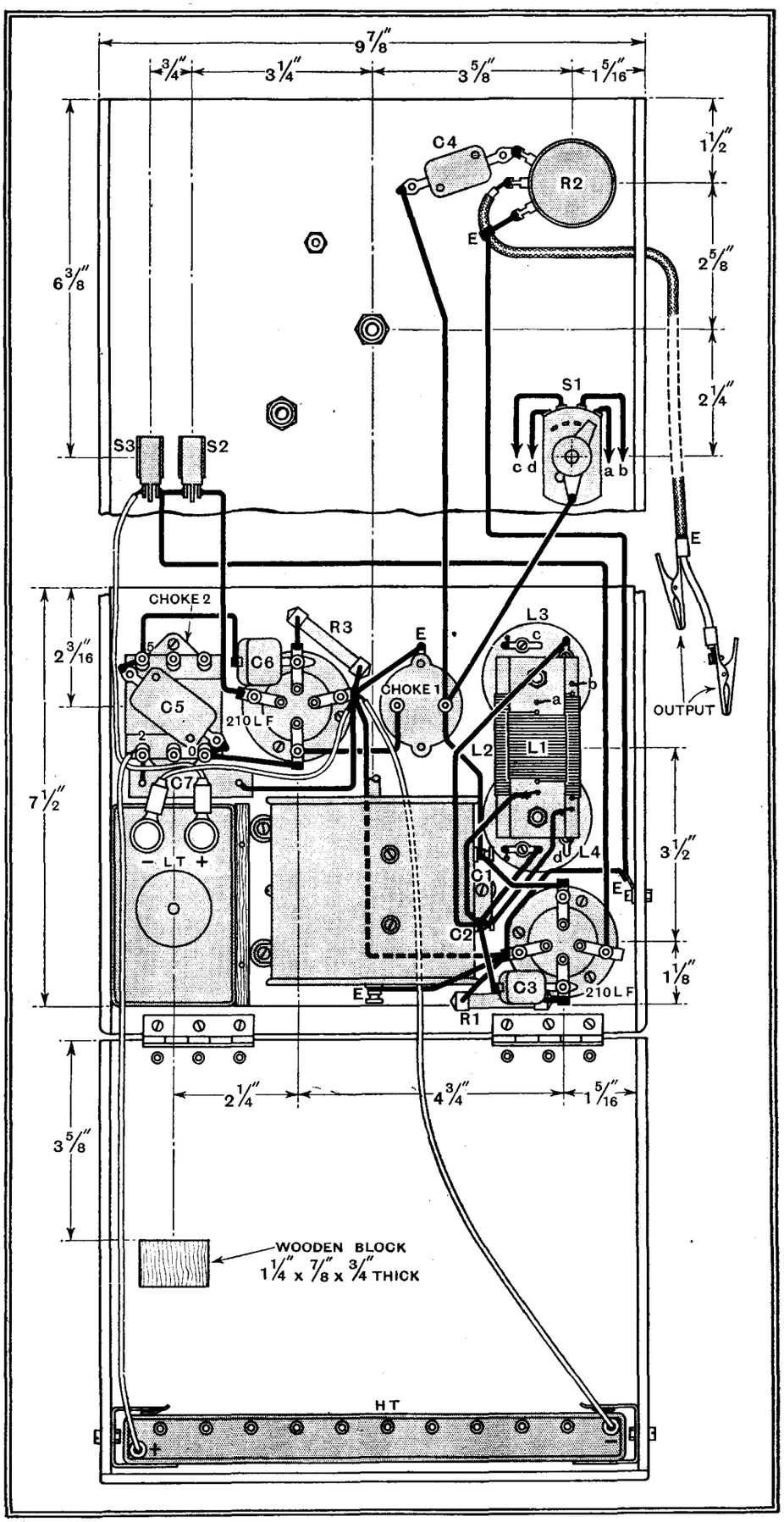
RANGE III.



RANGE IV.

The calibration curves of the four ranges of the original apparatus are shown here. Although the curves of other oscillators built to the same specification are unlikely to be identical they should not exhibit wide departures.

PRACTICAL WIRING DIAGRAM



The complete wiring plan of the equipment shows also the layout of components adopted.

tor should be adjusted so that it is sufficient for it to be audible.

Range 4 can be accurately calibrated in this manner, and Range 2 also. This latter band is roughly 380-900 kc/s, and there is no difficulty in obtaining a fundamental frequency calibration from stations between 546 kc/s and 900 kc/s. The rest of the band, 380-546 kc/s, is obtained by heterodyning stations in the 760-1,092 kc/s band by the second harmonic of the oscillator in the manner already described. On Range 3, direct calibration on long-wave stations is easy between 200 kc/s and 271 kc/s (stations between Droitwich and Moscow), and the band between 273 and 400 kc/s can be calibrated by heterodyning medium-wave stations between 546 kc/s and 800 kc/s by the second harmonic of the oscillator.

Range 1 is somewhat more difficult, and the errors are likely to be larger, although there is no reason why they should be serious. The greater portion of the range, 800-1,500 kc/s, can be directly calibrated from broadcasting stations tuned in on the receiver. The possibility of errors is here somewhat greater than on the other ranges only because of the greater difficulty of finding identifiable stations of known frequency in this portion of the wave-band. The stations here are usually of lower power and more inclined to wander in wavelength than those of lower frequency. Having obtained as many points as possible, particularly at the high-frequency end, they should be plotted and the curve drawn and extended to cover the uncalibrated high-frequency end as well as possible. Although this portion of the curve is not necessarily accurate, it will give a very close indication of the correct settings.

High-frequency Calibration.

The high-frequency end of the curve can be calibrated by heterodyning the fundamental of the oscillator with the *second harmonic* of broadcasting stations. To do this the oscillator will probably have to be connected directly to the detector circuit, for this is the only point at which harmonics are reliably generated. In the case of a grid detector, Fig. 2a, the oscillator should be joined between the high potential end of the tuned circuit and the grid leak and condenser. The trimming of the tuned circuit will, of course, be thrown widely out by this connection, but this is likely to be unimportant if the receiver is sensitive and strong stations are chosen. With a diode detector, the oscillator can be connected in series with the load resistance by-pass condenser, as in Fig. 2b, and this will not affect the trimming. The procedure is now the same as before when using harmonics, but the oscillator frequency is twice the signal-frequency instead of one-half. To calibrate the range of 1,500-1,750 kc/s, therefore, stations between 750 kc/s and 875 kc/s must be used.

It should be noted that this method of calibrating the high-frequency end of Range 1 is only applicable if a straight set

Modulated Test Oscillator—

is used. It will not work with a superheterodyne. If no straight set be available, calibration over this portion of the range is most readily achieved by rigging up a separate oscillator, which need not be screened, and calibrating it over the range of 750-875 kc/s. Calibration of the 1,500-1,750 kc/s band is then achieved by beating the second harmonic of this oscillator with the fundamental of the test oscillator.

Before starting the process of calibration, it is as well to mark the setting of the output control, since this has a slight effect on the frequency. In most uses of the oscillator it is not desired to know the frequency accurately, but if an exact indication be required, set the output control to the mark. The impedance of the external circuit into which the oscillator works will also affect its performance unless it be high compared with the output impedance of the oscillator. The output impedance varies with the setting of the control, which is inevitable with such a simple arrangement, and the external circuit should not be less than some 50,000 ohms when the full output is desired. When a small output only is required the impedance can be much lower.

The chief use of the oscillator lies in the adjustment of the ganging of any set and the IF circuits of superheterodynes, and a brief description of a typical method may be of interest. As an example, we will take a typical superheterodyne of modern design. Connect the earth lead of the oscillator to the grid bias source of the frequency-changer, and the other lead to the grid of this valve—the top-cap with heptodes, octodes, triode-hexodes and triode-pentodes, disconnecting the lead which normally goes to this point. Switch on the oscillator and modulation and set it to generate the particular frequency to which the IF circuits must be adjusted. If the note be audible, proceed to line up the circuits for the loudest signal or maximum change on a tuning indicator, obeying any special instructions which may be applicable to that particular receiver. If the note is not audible, swing the oscillator condenser to see if there be another setting at which it is. If such a point be found adjust the trimmers roughly to optimum at this point, readjust the oscillator towards the correct frequency point until the note is nearly inaudible, then readjust the trimmers and repeat until the oscillator note can be heard when it is tuned to the correct frequency, after which the adjustment can proceed normally.

Should it happen that the note cannot be heard at any setting of the oscillator, clip the oscillator leads to the grid of the last IF valve and its bias source and adjust the last IF transformer only. Then do the same to the preceding stage, if there is one, and finally, when the IF circuits are approximately in line, go back to the frequency-changer.

The ganging proper is carried out with the oscillator connected to the aerial and earth terminals, and as the procedure will necessarily vary with the type of receiver it cannot be adequately described here. In general, however, adjustments are carried out at 1,400 kc/s and 600 kc/s on the medium waveband, and at 175 kc/s on the long wavelengths.

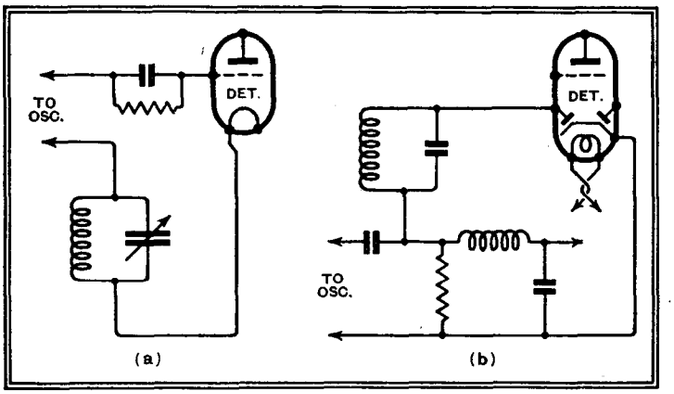
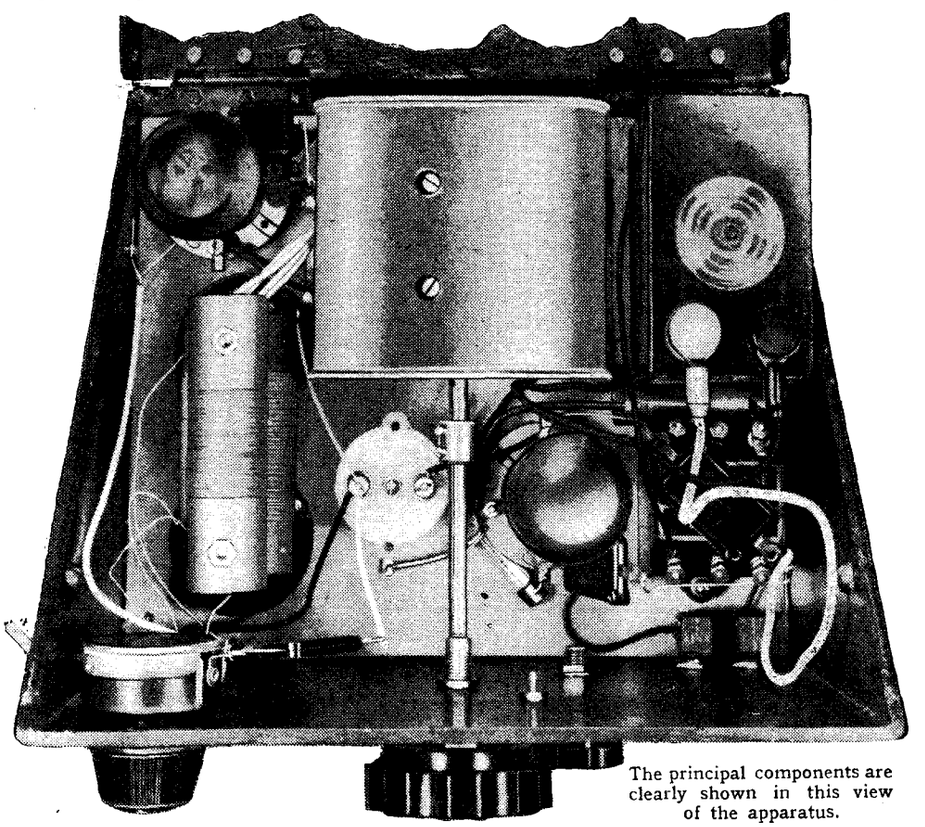


Fig. 2.—The method of connecting the oscillator to the grid detector of a straight set is shown at (a), and to the diode detector at (b). This is necessary when calibrating the highest frequency range.



The principal components are clearly shown in this view of the apparatus.

Trimming the "Raster"

A RECOGNISED method of generating the saw-toothed voltages used in cathode-ray television is to charge-up a condenser through a suitable constant-current device, such as a screen-grid valve. The gradual building-up of the voltage across the condenser plates controls the forward scanning traverse of the cathode-ray stream. When the condenser voltage reaches a certain critical value it is made to "trigger" a gas-filled or thyratron discharge tube. The resulting rapid discharge controls the "flyback" of the spot of light on the fluorescent screen.

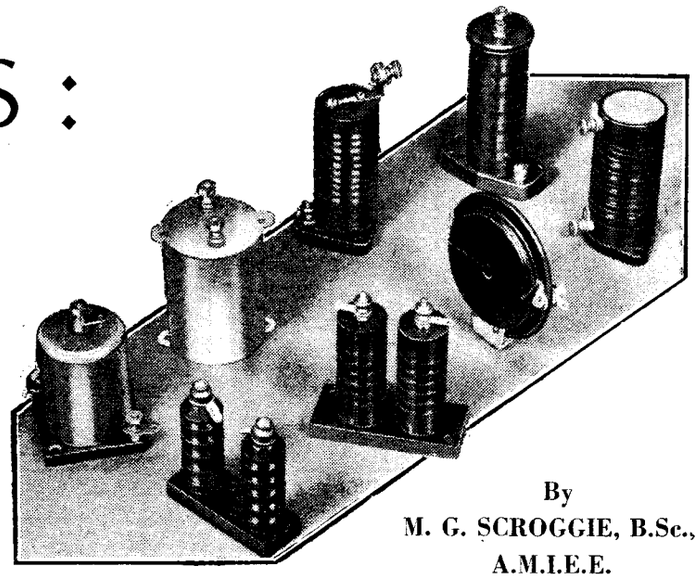
This sequence is repeated at rapid intervals to build up each complete "raster" or framework of scanning lines, a second similar arrangement operating at a lower frequency being utilised to change the picture some 20-25 times a second.

The synchronising impulses are usually applied to the grid, and it has been found that the charging time of the condenser is liable to be slightly lengthened or shortened according to the phase of the superposed grid voltages as the anode voltage approaches the "spill-over" value.

In high-definition work particularly this gives rise to a tendency for successive scanning lines to be slightly "staggered," so that the vertical edge of the raster has a serrated appearance instead of being perfectly straight. Similarly, when it comes to the "framing" frequency the complete picture may be "rocked" slightly, so that successive pictures do not perfectly coincide.

To eliminate these irregularities the D. S. Loewe Co. insert a low resistance in the condenser discharge circuit, preferably in the cathode lead of the gas-filled tube, where it serves as a ballast to stabilise the periodicity of the saw-toothed voltages.

HF Chokes: Construction and Performance



Various Popular Types Compared

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

DISPOSITION of windings has an important effect on the behaviour of an HF choke; the author discusses these peculiarities as they apply to various types in common use. It is shown in this instalment that the simplest and cheapest type of slab-wound choke has several serious shortcomings, and is suitable only for the less-exacting kind of function.

ALMOST every receiver includes one or more HF chokes. In the circuit diagram they are invariably denoted by the standard symbol for a coil, a circumstance which gives no hint of the astounding diversity of shapes and sizes which they assume "in the flesh." Seeing that chokes displaying a considerable variety of form are often specified as alternatives for a single position in a set, the question arises, are these differences in appearance important, or do they merely reflect the whim of the manufacturer? Are there any principles on which the constructor can select the type best suited to his purpose, or are these variations in appearance and construction immaterial? The answers to these questions will, it is hoped, become apparent in discussing this rather neglected component in detail.

The primary purpose of an HF choke is to discriminate between DC (and sometimes audio-frequency AC) and HF currents; allowing the former to pass, but barring the way for the latter.

As *inductance* offers no obstruction at all to DC but impedes AC to an extent proportional to the frequency, it might seem a simple matter to wind a choke coil to have enough inductance for any particular requirement. Unfortunately, a pure inductance is impossible for two reasons. A large inductance in a reasonably small space necessarily has considerable resistance also, and this sets a limit to the inductance that may be reached without also hindering the DC. And, on the other hand, the impedance to HF current becomes imperfect because of the stray capacity, so that as the frequency increases (and the wavelength diminishes) the impedance of the choke as a whole ceases to increase beyond a certain point and starts to decrease. The maximum impedance occurs at the frequency or wavelength at which the self-capacity and inductance are such as to cause resonance, and then the choke acts as a very high resistance. The lower the losses or ohmic resistance, the higher is this resonant or *dynamic* resonance. This is, of course, true of any sort of coil, such as a tuning coil. The position is further complicated by the fact that the self-capacity is not the same at all frequencies.

We are left, then, to do the best we can with this inevitable mixture of effects. What we want is—

high inductance,
low self-capacity,
low resistance,
freedom from multiple resonances,
freedom from coupling to nearby components,
compactness,

and, as always, low cost.

The extent to which it is worth while striving after a close approach to perfection depends on the purpose for which the choke is required. There are several quite different situations in which chokes are commonly placed, and the familiar fragments of circuit diagrams shown in Fig. 1 illustrate these.

Diagram (a) represents an "aperiodic" choke coupling, which is rarely seen now, though at one time it was almost universal in portable receivers. A screen-grid valve is shown, for a triode throws back so much damping into the input circuit that the amplification of the stage, never large at the best, is liable to be more than wholly lost. The choke is usually worked well below its resonant wave-

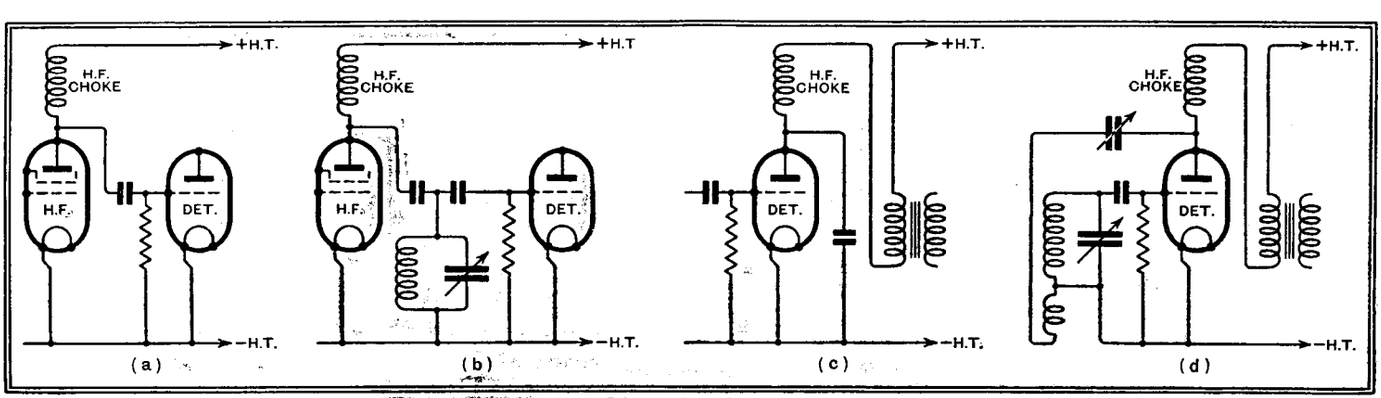


Fig. 1.—Positions in which HF chokes are commonly employed.

HF Chokes: Construction and Performance—

length, and it therefore acts as a capacity. The impedance of this capacity is not very large, particularly at the shorter wavelengths, but even if the loss of amplification caused thereby could be entirely abolished, there is that due to the stray capacity of the wiring and of the valve electrodes, so no amount of ingenuity devoted to producing a perfect choke avails to put this system on a satisfactory basis. It is clear, however, that a reasonably large inductance and small stray capacity are necessary. The usual values of about 0.15 henry (150,000 microhenries) and a very few micro-microfarads are satisfactory.

HF Chokes in Parallel

With a slight addition the circuit becomes the much more efficient "tuned grid" or "parallel-feed" arrangement of (b), which in spite of its similarity works entirely differently. Here the tuned circuit is, so far as HF circuits are concerned, in parallel with the choke, which is merely an unavoidable evil necessary for passing anode current. As the tuned circuit at resonance is in effect a very high resistance, it is important, first, that the choke should behave as a still higher resistance over the whole working range of wavelengths, so as not to cause a serious reduction in total resistance and consequently in amplification, and secondly, that its capacity should be small and constant, so that the tuning is not badly upset. This latter requirement is, of course, of prime importance if the circuit is to be matched for ganging or calibration; and both demands are much more stringent than in the previous application (a). A poor choke in this position ruins an otherwise well-designed stage of amplification.

In circuit (c) the choke is used in conjunction with a fixed condenser at the detector anode to keep HF currents from straying into the LF department. As before the choke must have a high impedance at all wavelengths concerned, but the results of imperfection are not nearly so serious as in the previous cases. The principal difficulty occurs when the radio frequency is low, as in a superheterodyne second detector, and the upper limit of audio frequency is high; then it may be necessary to elaborate the arrangement into a special filter to exclude the one and pass the other with satisfactory completeness.

In (d) also the choke is in the detector anode circuit, in this case to divert sufficient HF current for reaction control into the alternative path. That the requirements here are not very onerous is obvious when it is realised that in most cases the primary of the following inter-valve transformer is a sufficiently effective choke for the purpose. At least that is true on medium and long broadcast wavelengths. It may not be so true on very short waves, when there is usually less in hand for reaction purposes, and stray capacities become serious.

If the list of desirable features be examined again, it will be seen that they conflict with one another. To obtain a large inductance and low resistance, it is necessary to wind many turns of heavy-gauge wire, which procedure is not at all helpful in restricting size, cost, coupling, and capacity. It is, therefore, a matter of compromise.

In circuits (c) or (d), unless a screen-grid valve is used, there is liable to be trouble with instability if the choke is inductive, that is to say, if it is worked above its natural wavelength. To ensure that the natural wavelength is not less than 2,000 metres, an inductance of at least 0.15 henry is desirable. The resistance is not likely to be very annoying so long as it does not exceed 500 or possibly 1,000 ohms. As for the capacity, it should be as small as possible.

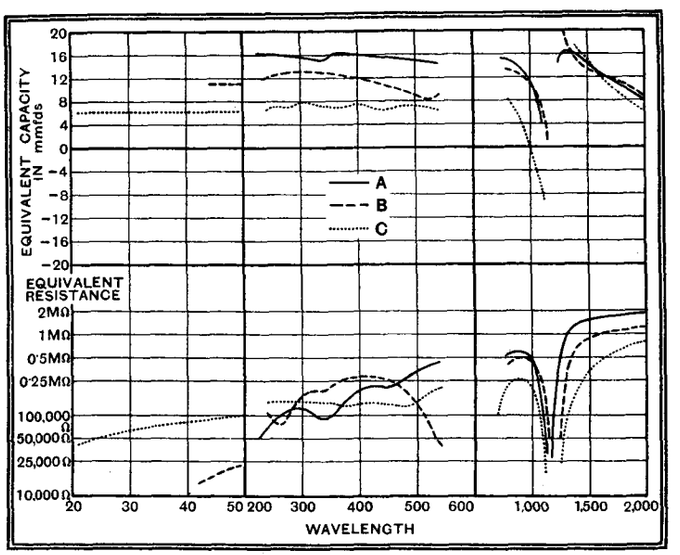


Fig. 2.—Characteristics of three typical slab-wound HF chokes compared.

A single-layer coil being out of the question, and a "pile" winding generally inconvenient, the usual method of keeping the capacity low is to wind the wire in a narrow slot.

Such a construction, giving a single concentrated winding, has the virtues of simplicity and cheapness. Its usefulness can be judged from the results of tests on representative specimens, which have been lettered alphabetically for reference. The object of the tests has been to arrive at the values of high resistance and capacity, which, if substituted for the choke, would produce an identical result *at that particular wavelength*. The ideal choke would have an infinitely high reactance and no capacity—so that nobody would know that it was there, except for its ability to conduct unvarying and low-frequency currents.

The method of test is to connect the choke across a tuned circuit maintained in oscillation by a screen-grid valve acting as a dynatron. The addition of the choke has two effects; first, it shifts the frequency of oscillation, which can, however, be restored by adjustment of a variable condenser in parallel with the tuned circuit. This condenser is calibrated in micro-microfarads, and, therefore, indicates directly the equivalent capacity of the choke. If the choke is inductive, the equivalent capacity is negative.

Secondly, the valve oscillates less easily. Oscillation is controlled by a variable negative grid bias, which can be read on a voltmeter, and the point at which oscillation just ceases is noted before and after connecting the choke. The resistance corresponding to any change in the reading has previously been found by observing the effect of connecting a number of known high resistances.

Naturally, the higher the resistance, the smaller the leakage, and the less the tendency to stop oscillation.

Chokes A and B are very similar makes, both being wound with enamel-covered wire in one section on bakelite bobbins, $\frac{1}{2}$in. internal diameter, $1\frac{1}{8}$in. external diameter over the wire, and the winding space is $\frac{1}{4}$in. wide. The inductance in each case is about 0.15 henry at low frequency, and DC resistance 380 ohms. The curves of Fig. 2 show the equivalent resistance and capacity, and it will be seen that the results are also very similar though they differ in detail. The equivalent resistance of A is so low that short-wave tests were not possible at all, which means a figure less than 15,000 ohms—cruel damping for a tuned circuit — and B could be pursued only down to 42 metres. There are sundry irregularities on the medium waveband, but in the long waveband there is such a violent absorption of energy as to amount practically to a short circuit. This feature is not likely to be helpful in the circuit of Fig. 1 (b).

Simple Confirmatory Test

These results may give rise to a suspicion that the measuring circuit and/or some other external influence is responsible for the severe absorption shown at about 1,200 metres. The method of test excludes such a possibility, however, and further confirmation is given by the effect of connecting chokes A, B, and C across any of the tuned circuits of a receiver operating on that wavelength. The tuning is shifted enormously, and even when re-adjusted to the best setting, reception is only a fraction of normal strength. Oscillation is rendered difficult or impossible. Other chokes that do not show this excessive absorption may be connected across even a good tuned circuit with barely perceptible effect. A choke resistance of 100,000 ohms or lower has a bad

HF Chokes; Construction and Performance—

effect on even a moderately efficient circuit.

It will be noted that at wavelengths where the equivalent resistance is steady, the equivalent capacity is steady also, in the neighbourhood of 12 m-mfds. But where there are absorption "hollows" the capacity fluctuates, and with these and all other chokes it does so in the same characteristic way; where the resistance curve is steep *downward*, the capacity is *low*, and vice versa. Mathematicians have a special name for this effect.

The explanation of these absorption hollows is that the inductance and self-capacity of a coil are not fixed and definitely localised quantities, but are distributed over the whole winding, and each part of the winding is coupled to every other part. We usually think of a coil as an inductance with a small self-capacity shunted across it, Fig. 3 (a), and this is fairly true to life at long wavelengths. At the natural wavelength the impedance of these two paths is equal and the whole acts as an extremely high impedance; a so-called rejector circuit. At wavelengths higher than this, the choke acts as an inductance and at lower waves as a capacity. Now, there is nothing to prevent us from thinking of a single coil as two coils in series, one large and one small. If there are 1,000 turns altogether we may imagine the first 900 as making one coil (complete with its own self-capacity), and the remaining 100 turns as another. Fig. 3 (b). At certain wavelength, the easiest path may be the self-capacity of the large part and the inductance of the small part. Most of the HF current will, therefore, follow the heavy line. It may happen that the impedance of these two sections is equal and opposite, in which case we have a perfect *acceptor* circuit, Fig. 3 (c), which is not quite what is wanted!

The single-slot choke is liable to this effect, with the results shown in Fig. 2.

With the object of reducing the high capacity of the wide single-winding choke, which leads to such a poor showing at short wavelengths, a narrower slot is sometimes used. Type C is 5/64in. wide, and 1½in. external diameter; the inductance and DC resistance are much the same as A and B. The alteration of shape is successful in cutting down the capacity to about 6 mmfd. and enabling it to function right down to 20 metres, though the absorption is fairly severe. Even on medium waves the equivalent resistance is well below quarter of a megohm, and though it is much less over most of the long waveband, the fearful crevasse still remains in the middle.

Quite apart from this last defect, the capacity is still rather high for use across a tuned circuit and for short-wave purposes. It cannot be reduced without reducing the diameter. And if the diameter is very small, excessively fine wire is necessary to maintain the required inductance. So a common remedy is to split the winding up among a number of slots. To make the capacity very low at short waves the end slots are sometimes made smaller than the others. Choke D has one slot only ⅝in. diameter and 3/64in. wide, the remainder being 1in. by 1/16in. This idea is tremendously successful in achieving a low short-wave capacity, for in this particular case it is only 0.7 m-mfd., and the absorption even at 20 metres is about half a megohm. This satisfactory state of affairs, unfortunately, does not extend throughout the medium and long wavebands, for there is a nasty dip at 265 metres down to about 60,000 ohms, a slight one at 850, and another rather deep one at 1,650. Along with all these are corresponding undesirable wriggles in the capacity curve.

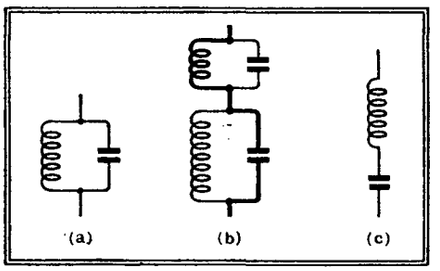


Fig. 3.—Illustrating the distribution of self-capacity.

The explanation which has been already given to account for single-coil misbehaviour will generate a suspicion that in choke D the individual sections are resonating on their own; the inductance of one group against the self-capacity of another. To settle any doubts as to the correctness of this, an interesting test was applied. Copper wire alters its resistance about 0.4 per cent. for each degree rise in temperature. The resistance of each section was measured, and the choke was then connected to a much more powerful oscillator, with an output of several hundred volts, and tuned to the crevasse at 265 metres. After a few minutes of this it was removed and the resistances rapidly remeasured. One part of the choke showed a temperature rise of over 40° C., while the others were practically as cool as originally. Other chokes were tested in this way, and the distribution of temperature rise compared with that due to heating by DC, and such tests prove conclusively the existence of local resonance. The distribution alters with the wavelength used for "cooking."

The mixed-section choke is particularly liable to have a sprinkling of absorption hollows, and there is therefore some reason for favouring the equal-section type if all waves are to be covered.

Choke E is an example of this, with ten equal slots 1in. in diameter by 3/32in. wide, total length 1¾in. An iron core is used, incidentally, which enables the large inductance of over 0.3 henry to be obtained at low frequencies, with a DC resistance of only 200 ohms. Although this would seem to render it useful mainly at the higher wavelengths, it is remarkably good on the short band, with barely 3 m-mfd. and less absorption than type D as far as 25 metres, below which it falls away slightly. There is a broad dip at 520 metres, where the resistance is as low as 60,000 ohms, but elsewhere it is mostly in the half-megohm region. And there is no unpleasantness in the long waveband, while, as might be expected from the high inductance, the capacity does not go negative below 2,000 metres.

(*To be concluded.*)

"Ultra-Shorts" on Ben Lomond

SCOTTISH amateurs are well to the fore in ultra-short-wave experiments, as was proved on Sunday, May 5th, when signals on 56 megacycles from an amateur station, G6ZX, situated in Clarkston, near Glasgow, were picked up on the summit of Ben Lomond, thirty-three miles away.

Preliminary tests had been conducted in and around Glasgow, but it was decided by members of the Glasgow and District Radio Club that something more was required to create more interest.

The ascent of Ben Lomond proved an arduous task for members, who had to climb 2,000ft. before the first of three transmission tests took place, carrying receivers, batteries, and other impedimenta.

Reception on the summit.

G6ZX, transmitting speech and gramophone records, used a directional aerial and had no difficulty in providing the mountaineers with good signal strength. After the first tests packs were again shouldered and the climb towards the summit continued. At 2,500ft. signals had risen to full loud-speaker strength with an input at the transmitter of 8 watts. When the party reached the summit G6ZX increased the power to 10 watts, when intelligible reception was possible twenty yards from the headphones.

Current Topics

Events of the Week in Brief Review

Nearing Seven Million

GERMAN licences totalled 6,734,745 on May 1st, an increase of only 9,529 in a month.

Indian Broadcasting

INDIA is to have a broadcasting station at New Delhi, to begin transmitting in November next. The transmitter will have a power of 20 kilowatts.

Television at Olympia

COMPLETE television transmitters and receivers will not be exhibited by individual manufacturers at the autumn radio shows at Olympia, Glasgow and Manchester. It is understood that the Radio Manufacturers' Association may stage a demonstration of high-definition television.

5-metre Drill

ALTHOUGH few sights are more impressive than a regiment of cavalry with their quivering lances, the American Army is going one better in equipping mounted troops with di-pole aerials. These are to be used in forthcoming manœuvres to enable commanding officers to issue words of command at great distances on ultra-short-waves.

No doubt regimental sergeant-majors will soon be equipped with button "mikes" and 5-metre transmission packs so that they can drill their battalions a mile away with a mild whisper from the mess.

An Independent Move

AN official "indiscretion" has revealed that France is installing a high-power short-wave station at Villejust, Seine-et-Oise, for direct broadcasts to America, thus avoiding the use of cables belonging to other countries.

Egg-hatching by Wireless

A GOOD bird story comes from Newark, New Jersey. Engineers of station WOR discovered that when a meadow lark built its nest inside a discarded coil of wires near the station, it found that the heat picked up by the wire from the 50-kilowatt transmitter was ample to hatch the eggs without any parental attention except when the station was silent. Other birds in the neighbourhood came to grief when they attempted to emulate the lark by winding bits of wire around nests already built. When they used too much wire the result was cooked eggs, and when they used too little the eggs were underdone.

French Regional Scheme

DELAY is once again rearing its ugly head in the sphere of French broadcasting, and two important stations in the French Regional scheme, PTT-Nord and Toulouse-Murat, are already overdue with their tests. According to a correspondent, all the apparatus is *in situ*, but the high-tension supply is not yet available.

BRIDGING CONTINENTS. Four sets of bridge hands, shuffled in Sydney, were dealt out to players 10,000 miles away in both North and South America on April 29th, and a spirited match ensued by short wave. The picture shows Messrs. Lang and Lockton, "west" and "north" participants, in play with partners at Barranquila, Colombia.

Morals and Wireless

ROUMANIAN applicants for receiving licences must furnish to the Postal Department a number of certificates, including one from a priest confirming that the would-be listener is of high moral integrity.

D.F. Competition

A DIRECTION - FINDING field day will be held by the Golders Green and Hendon Radio Society in the Chipperfield (Herts) district on Sunday, May 26. Operations will be conducted on a wavelength of 80 metres. All amateurs interested should apply for full particulars to Lt.-Col. Ashley Scarlett, 60, Pattison Road, N.W.2.

"Ultra-shorts": London and Birmingham DX?

LAST week we gave full particulars and schedule of the ultra-short wave transmissions from the roof of the *Daily Telegraph* building in Fleet Street, London, on Sunday next, May 19, by the International Short Wave Club (G5KA). An interesting feature of the tests will be an attempt to set up two-way working with station G6SL, Birmingham, operated by Stratton and Co., Ltd.

G6SL, employing a transmitter of new design with a power of 50 watts, will test on 58 megacycles, and a special ultra-short wave aerial array will beam the transmissions towards London.

America's Record

A RECORD year for the American wireless industry is reported by *Radio Retailing* in its statistical survey of the U.S. trade for 1934. No fewer than 4,696,000 radio receivers were manufactured in the United States last year, of which 612,000 were exported abroad. The high figure of two-and-a-quarter million replacement sales is attributed to the fact that many people, attracted by the prospect of all-wave reception, invested in new sets. It is estimated that 69 per cent. of American families now possess a receiver.

Over 65,000,000 valves were manufactured in U.S.A. last year.

Broadcasting at 16,000 feet

WITHIN the next day or two the Moscow (Komintern) "spoken journal" will incorporate a broadcast from scientists on the summit of the Kazbeck mountain, some 16,546 feet above sea-level. A short-wave transmitter, specially constructed for the event, has been taken up to the summit, whence the scientists will describe the results of their researches.

Car Radio: Official Blessing

IN a letter to the Radio Manufacturers' Association, Mr. Hore-Belisha, Minister of Transport, has expressed his approval of car radio receivers, undertaking not to make regulations relating to them without first consulting the Association. He emphasises, however, that automobile sets should not be operated at a volume likely to cause annoyance to the public.

"Normandie" Relay to U.S.

AMERICAN radio networks will "cover" the departure and maiden voyage of the giant new French liner "Normandie" when it sails from Havre for New York on May 29th. Commentaries and sound pictures connected with the departure ceremonies will be relayed on short waves. Both the N.B.C. and Columbia networks have sent announcers and technicians to Havre.

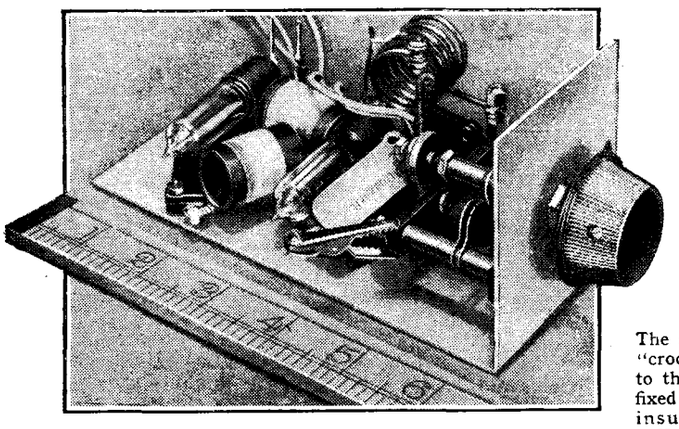
M. René Arnaud, who came to London to give Radio-Paris listeners an eye-witness account of the Jubilee procession and service in St. Paul's.

Five-Metre Super-Regenerator

An Effective Receiver for Ultra-short Wavelengths

By G2AW

THE author, a successful experimental transmitter, whose call-sign is well known to amateurs who work on the ultra-short wave band, describes a remarkably simple and inexpensive receiver with which valuable first-hand experience of the behaviour of waves between 5 and 8 metres may be obtained.



The stray capacity of a "crocodile" clip attached to the aerial lead-in and fixed to the condenser insulation, provides sufficient aerial coupling.

INTEREST in ultra-short waves has been greatly stimulated by television, and, by the time the British service begins, a large number of amateurs will have obtained at least a nodding acquaintance with the peculiar properties of the extremely high frequencies to be used for both vision and sound broadcasts. Even now, there is a good deal of activity; the 180-line Baird transmissions are continuing experimentally, a number of amateurs are active, especially around London and many experimental Services and commercial transmissions are taking place.

It is generally acknowledged that the short range of ultra-short waves is really a special advantage of this band, although it must be admitted from some points of view it is hard to regard it in that light. So far as we know at present, the waves are only receivable at quasi-optical ranges, but when both transmitter and receiver are situated on high ground, signals may carry as far as 100 miles.

Circuit Details

A receiver to pick up the various transmissions between 5 and 8 metres is surprisingly easy and inexpensive to construct, and the set to be described in this article, though more than usually simple, has proved to be surprisingly effective. To avoid misunderstanding it should be stated that the principle employed is unsuitable for the reception of vision, but the set provides a good introduction to the behaviour of ultra-short waves in general. The set is for headphone reception, but could be modified for loud-speaker work; the model illustrated is also extremely compact, but this compactness is only incidental, as the general principle will apply equally well to any constructional layout.

From the circuit diagram of Fig. 1 it will be seen that the very minimum of parts are used. The first valve V1 acts as a super-regenerative detector of the self-quenching type. Reaction is obtained by coupling the filament to the grid coil and keeping the anode at low HF potential by means of the relatively large condenser C2. The quenching frequency is dependent upon the values of the grid condensers and leak (C5 and R1). The valve V2 is simply an LF amplifier.

The combined detecting-quenching circuit operates in this manner: the valve is in a state of such violent oscillation that the charge on the grid condenser cannot leak away quickly enough through the grid leak, with the result that the resistance of the circuit becomes positive and oscillation is momentarily damped out. When the condenser charge does finally dissipate the grid again rises to a less negative potential and oscillations recommence.

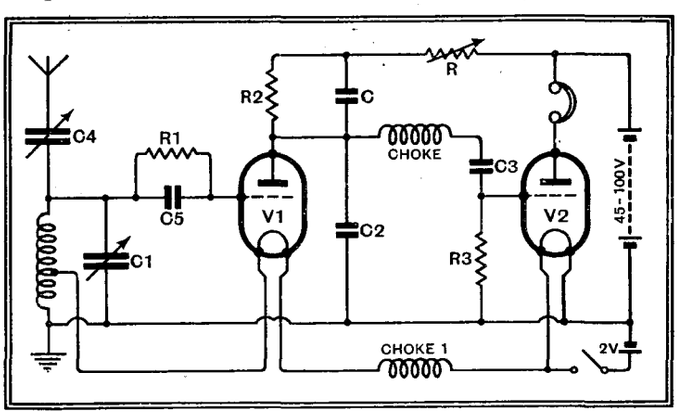


Fig. 1.—Complete circuit diagram. Values of components: R, 0.25 megohm, variable; R1, 0.25 megohm; R2, 20,000 ohms; R3, 0.5 megohm; C, 0.005 mfd; C1, single plate, 15 m-mfds (approx.); C2, C3, 0.005 mfd; C4, 6-10 m-mfd; C5, 0.0001 mfd: CHOKE and CHOKE 1, see text.

This cycle of events repeats itself indefinitely, with the result that self-oscillation is interrupted with a regular periodicity.

This starting and stopping of oscillation (or quenching) is, as already stated, dependent for its frequency upon the values of grid condenser and leak; for a fixed condenser the frequency will be reduced by increasing the value of grid leak resistance. A low quenching frequency offers the advantage of increased sensitivity, but poorer quality; a very low quenching frequency will become audible as a note in the phones, making speech less intelligible apart from its unpleasantness. The values given in the circuit have been found to provide satisfactory all-round quenching, but for maximum sensitivity it is worth while trying a grid leak of about 0.5 megohm. When the functioning of the circuit is clearly understood there is no difficulty in adapting it for various valves and components.

Points for Constructors

In deference to established custom, a control of regeneration is shown in the diagram in the form of a variable resistance R of $\frac{1}{4}$ megohm. However, the writer contends that this serves no useful purpose and it is not employed in the receiver shown in the photographs.

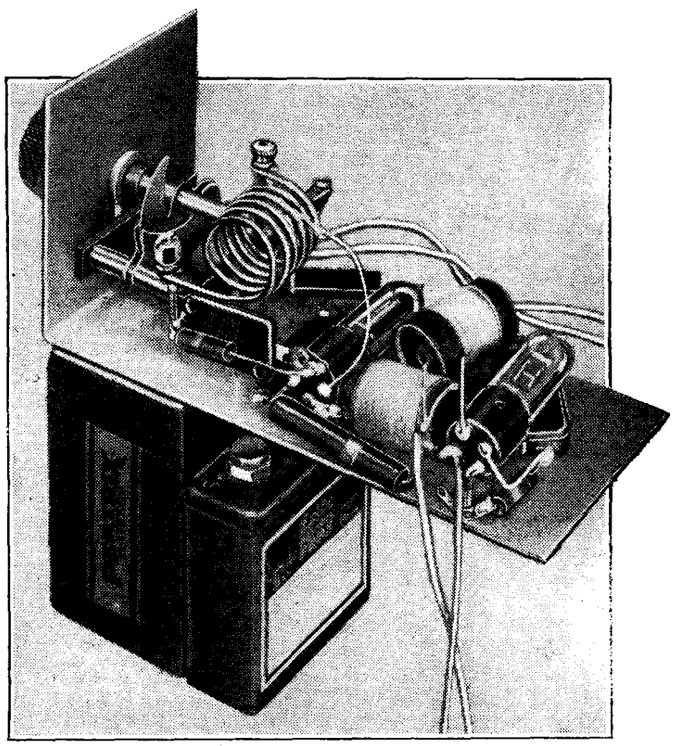
Layout of components is of little importance, provided that the following points are borne in mind. The detector valve leads should all be very short and, in particular, the large condenser C2 of about 0.005 mfd. should be connected as directly as possible both to the plate pin of the valve and to the earthed end of the grid coil. The coil itself is best connected directly across the variable condenser terminals. This condenser, by the way, is of the single-plate type, that used by the writer being a J.B. component of 15 m-mfds.

Aerial coupling should be very loose; it is controlled by the coupling condenser C4 for which a maximum capacity of 10 m-mfds is more than ample. Indeed, the stray capacity between a crocodile clip connected to the aerial and clipped on to the insulating material of the condenser, as shown in an accompanying illustration, will serve the purpose admirably if somewhat crudely. The coupling

Five-Metre Super-Regenerator—

can be adjusted by moving the clip with relation to the metal part of the condenser stator.

For reception on the 5-metre band the tuning coil consists of 5 turns of No. 14 SWG bare wire wound on a ¾in. round former and then removed so that the turns may spring apart. The 7-metre coil is similar, but has 9 turns; both are tapped at the third turn from the earthed end. A pair of tiny chokes are needed, and as one of them has to carry filament current its resistance should be low. Actually both may be identical, the winding consisting of between 30 and 40 turns of No. 24 DSC wire on ½in. formers.



An extremely compact self-contained set may be made up by using a miniature 45-volt Pertrix battery and an Exide PRP3 3-ampere-hour LT cell. Space for a single headphone can be found behind the accumulator.

Hivac Midget valves (type XL) have been chosen by the writer for their extremely small size and low capacity. It is easy to solder them directly into the set, but the only result of using valve holders will be slightly to curtail the tuning range. Other valves such as Marconi or Osram HL2K can be used successfully provided about half a turn be removed from the tuning coils and in some cases alteration be made to the position of the tapping. High-tension voltage depends on the type of valve; for ordinary valves from 100-120 volts may be needed while the Hivac Midgets work well on between 45 and 100 volts.

As the tuning condenser spindle is at low HF potential there is no need for the usual anti-capacity extensions and no special precautions need be taken in tuning.

Before starting work it is a great advantage to be able to check the wavelength of the receiver, and this is best done by means of a resonant transmission line. Two accurately cut 43in. lengths of 16-gauge copper wire, spaced about 1in. apart on a piece of plank by means of brass brads will serve the purpose. The wires are joined together at one end and if this closed end is held close to the grid coil of the set, oscillation will be stopped. This point corresponds with the low-frequency end of the 5-metre band. A similar "wavemeter" for the 7-metre band is made with 5ft. 6in. lengths of wire.

The receiver will work well with the usual broadcasting aerial, provided that the coupling be made loose enough to avoid "dead spots." Alternatively, splendid results can be obtained from a vertical length of wire about 6½ to 8ft. long; this type of aerial can, of course, be mounted indoors. It is a great advantage to have available both horizontal and vertical aerials, as their receptive powers will be affected by the nature of the transmission, and an experimental change-over is always worth trying.

Short-wave Broadcasting

IT was fortunate that short-wave conditions were unusually good on Jubilee Day; indeed, they appeared to be as perfect as the weather, with the result that the Colonies and Dominions, as well as many foreign countries, received the King's speech more clearly than ever before. The few disgruntled people who still consider that the Empire Station is a failure must be die-hards indeed if they do not admit that May 6th, 1935, justified its existence.

Short-wave conditions, in general, have been so excellent during the past few weeks that many stations not hitherto identified are being picked up quite regularly. The station at Suva, Fiji (VP1A), recently mentioned in these columns, is an example. At the time of writing this station has not been definitely identified in London, but has been followed clearly by more than one reader in the Midlands and the North.

By the time this is in print he will probably have been heard at better strength in London. The writer and several others have listened to his carrier-wave, which comes on at 6.30 a.m. and switches off at 7.30, but it has been subject to quick and severe fading, which has made it almost impossible to detect any modulation.

For readers' information, this station works on 22.94 metres, and its chief interest lies in the fact that it is just about as close to our Antipodes as one can get.

Amateur-band conditions, with especial reference to the 20-metre band, continue to act as an excellent guide to what we may expect to receive on the broadcast waves. A week before writing this the only stations audible on "20" in the early morning were Hawaiians. As they faded out (after a few days) they seemed to be replaced by West Coast Canadians (British Columbia and Alberta, in particular). At present the West Coast Americans (Oregon, Washington and California) are beginning to come in, and they should, by comparison with previous logs, continue to come over well until the end of June or July.

Sydney (VK2ME) is becoming a little difficult to receive on Sunday afternoons unless one has a really selective receiver. With Rome and the two Zeesen stations all transmitting within 30 or 40 kc/s of his frequency the clear reception of Sydney is not too simple a matter.

There are indications that more use will be made of the 16- and 14-metre broadcast bands as the sun-spot cycle progresses. Certainly conditions are more favourable for those bands, even now, than at any time since 1928. The 19-metre band, likewise, is at its best, and the programmes from W8XK and W2XAD may be received during the evenings at tremendous strength.

A small experimental receiver consisting of detector and pentode only has been giving real loud speaker results on these two stations for over a week. Big superheterodynes produce such shattering results that liberal use of the volume control is necessary unless one wants to remove the pictures from the wall!

Rio de Janeiro (PRF5), on his setting at the top of the 31-metre band, is remarkably consistent by comparison with the other South Americans. Night after night this station is received at practically the same strength, and with less fading than ever before.

The 49-metre band is a little troublesome owing to the strength of some of the "locals" after dark, and is also rather spoilt by atmospherics, which are beginning to assume their summer proportions already. During the small hours, however, all the Americans on that band are excellent.

MEGACYCLE.

BLUE PRINTS

For the convenience of constructors desiring to build apparatus for the reception of short-wave stations, full-sized blue prints are available of the following sets that have been fully described for home construction, price 1s. 6d. post free.

1935 AC Short-Wave Receiver, 12-70 metres. (HF-det-Pen with valve rectifier, in two units.) **Aug. 31st and Sept. 7th, 1934.**

AC Short-Wave Converter, 13.5-50 metres. (Two-range Superhet Unit.) **April 12th and 19th, 1935.**

These can be obtained from the Publishers, Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

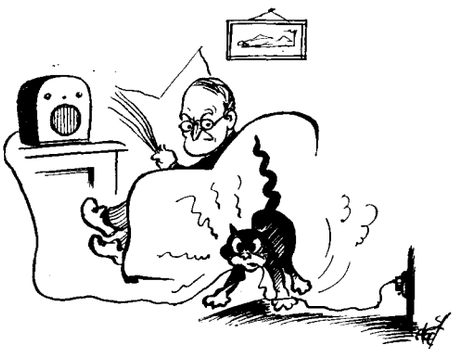
UNBIASED

By FREE GRID

Felix Keeps on Biting

LIFE seems to be made up of nothing but troubles and the intervals between. Soon after one problem is solved, satisfactorily or otherwise, another rears its ugly head.

At the present moment I am at grips with a particularly knotty one which I think will take all the skill of our electrical manufacturers to solve in a proper manner. My trouble has to do with an objectionable habit which has been suddenly developed by the particular specimen of *felis domesticus* which uses my home as an hotel in which to eat and sleep during the intervals between its nocturnal wanderings.



Laudable attempt to commit hari-kiri.

The animal has suddenly developed an unfortunate propensity for chewing the flex which joins my various pieces of wireless apparatus to the mains. While I do not wish to stand in its way in its laudable attempt to commit hari-kiri, I do strongly object to footing the bill for new flex every few hours. When it started the game I thought that the problem would automatically solve itself as soon as the cat got through the entrée in the form of silk and rubber and down to the real *pièce de résistance* of its meal.

But cats are, apparently, made of sterner stuff. Beyond a vicious spit and arching of the back as soon as pussy got down to the bone, nothing happened, and its appetite for more does not seem to have been killed, judging by its subsequent behaviour, as it has already started on its third effort.

A naturalist friend tells me that 240 volts are nothing to a cat, although sad cases have been recorded where puppies, given to the same playful pastime, have instantly succumbed. A similar thing has been known to happen to babies, although nobody who has been so unfortunate as to dwell next door to one will shed many tears over that.

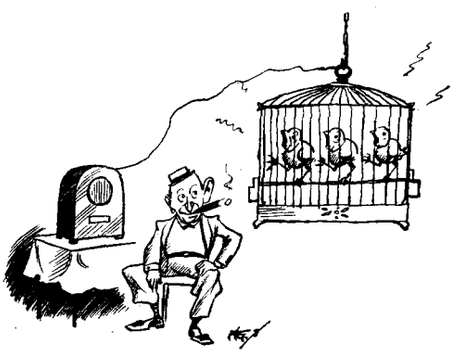
My problem now, of course, is to find some brand of flex the insulation of which has been impregnated with a substance to which cats have an aversion. I have an æsthetic objection to the use of lead-covered wire as "flex," and if no worthwhile advice is forthcoming from any of you the only thing I can see staring me in the face is the complete abandonment of all-mains wireless in favour of a battery-driven receiver. The thought of such a things is an absolute nightmare to me, but what else can I do? I may say that I am considerably surprised that some of the animal protection societies have not taken this matter up as there must be some thousands of dogs and cats who are addicted to this painful habit.

Any animal lovers who wish to avert an unfortunate incident can do so by offering a good home either to me or the cat; but they will have to act quickly.

On With The Motley

AN outcry has arisen in one of the Southern states of the U.S.A. against the growing use of canary cages as short-wave aerials. Apparently somebody hit on the idea of twisting a bit of flex round one of the bars of a canary's cage to bring in short-wave stations, and immediately found that the size of his bag was doubled during an evening's hunt round the dials.

He wrote to the local papers about it, and the idea caught on, with the result that manufacturers of these cages became overwhelmed with orders. Of course, a



They sang in time and tune.

canary's cage suspended from the ceiling does, I suppose, form a convenient capacity aerial, but any other lump of metal would serve the purpose equally well.

Now, the curious point of the whole business is this. Not only has there been an unprecedented run on canary cages, but the demand for birds also has been so great that the supply has run out, and unscrupulous dealers are supplying painted sparrows. I can understand that there are strong humanitarian objections to the painting of sparrows, but the good folk who are making an outcry are ignoring this. Their shout is about cruelty in another form.

Apparently some ingenious bird fancier, fired by the idea of increasing his turnover, wrote to the paper and announced that when the canary cage was wired up as an aerial, not only did the birds sing much better, but they sang in time and tune to the loud speaker. This was due, so he alleged, to the fact that their voices were forced into step with the fluctuations of the electric and magnetic fields surrounding the cage. The afore-mentioned fancier was apparently forgetful of the fact that the oscillations would be at radio frequency, and so would have no relationship to the frequencies of the musical spectrum, but apparently this is a small point in America.

At any rate, everybody fell for it, and the unfortunate sparrows have had to suffer.

Meanwhile, the bird fancier has reaped a rich harvest, and I should not be surprised if in the end it was found that it was a cage maker who originally discovered the virtues of using a cage as an aerial.

Waylaid

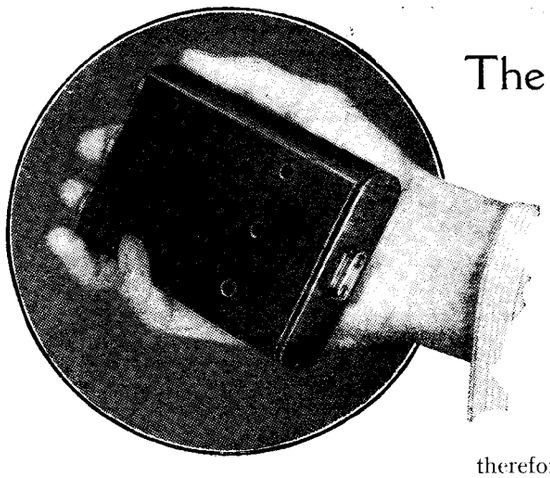
I AM sorry to say that my unfortunate features are becoming a little too well known as a result of constant publication in the columns of this journal. During the past month I have been stopped no fewer than three times in the streets of London by people who seem to imagine that there is a reward for spotting me.

At any rate, in each case my waylayer drew my attention to the fact that he was carrying a copy of the current issue of *The Wireless World*, a similar condition being necessary, I understand, for winning the prize in the case of the man-hunts organised by the daily newspapers. In

Go about in disguise.

each case I have had to deny my identity, much as it goes against my moral principles to tell a deliberate untruth.

If the nuisance occurs again I shall be reluctantly compelled to go about in disguise.



The Gordon Magnesium Battery

A New Design of Interesting Performance

By R. W. HALLOWS

THE battery here described is not just yet available, but is being put into production in this country. Its application for use with portable receivers, deaf aids and similar small outfits is particularly promising.

THE Gordon magnesium cell, which is at present being developed by one of the most important engineering firms in this country, is particularly interesting, since it strikes out on entirely new lines. In its electrodes, its electrolyte and in its performance it is completely different from any other primary cell.

To save readers from writing letters that can serve no purpose may I say that neither the cell nor batteries made up from it are yet on the market, and that I have promised not to divulge the name of the makers until they announce that they are ready to meet the demands of the public?

In all primary cells that have hitherto come widely into use current is "generated" by the chemical action of the electrolyte upon zinc. Zinc seemed to be, perhaps, the obvious metal for the purpose: it is plentiful, it is reasonably cheap, it is not unduly heavy, and it provides an EMF of between one and two volts per cell, according to the electrolyte and the other electrode used. But all zinc cells have one defect in common, which is that as soon as they are placed under load what is known as polarisation sets in, steadily increasing the internal resistance and making the current fall away toward zero. To counteract this effect a depolariser is necessary, which must occupy a good deal of space and add largely to the weight of the cell if it is to be effective. The Leclanché cell, which is now probably the most widely used of all, achieved its popularity because it employed a semi-solid depolariser and could, therefore, be made up in "dry" form with a paste or jelly electrolyte. But the action of the depolariser in even the best of Leclanché cells is sadly inefficient unless the load is very small.

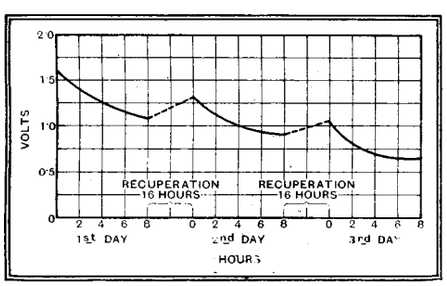


Fig. 1.—Intermittent test, 3 days, 8 hours a day through resistance of 15 ohms (initial current 100 mA) of Leclanché cell of similar size to those used in the Gordon battery the performance of which is seen in Fig. 3.

The only completely satisfactory depolariser is one where the action is so nearly instantaneous that the causes of rising resistance are removed as soon as they occur. In the Leclanché cell this does not happen; when the cell is in action the depolariser can never quite keep pace with the rise in internal resistance. Hence the EMF is continually falling, and the current delivered must fall with it. Rest the cell for a time and the depolariser asserts itself. The internal resistance is reduced by its action and the cell recuperates to some extent.

Fig. 1 shows a discharge curve over three days for a typical Leclanché cell, which was run on each day for eight hours continuously and then rested for the remaining sixteen. Two points will be noticed. First of all the EMF falls heavily during each "run," and, secondly, it is never quite as high at the beginning of any "run" as it was at the beginning of the previous one.

Construction of the Cell

The construction of the Gordon cell is shown in Fig. 2, and an examination of the drawing shows immediately how unorthodox it is. Each cell consists really of four small ones in parallel, this form of construction (which has also been used to some extent in Leclanché cells) being chosen because, volume for volume, the electrodes have a much larger surface area than is the case where each is but a single piece of material. In the drawing, one of the four units is shown cut away so that its internal construction may be seen. It consists of a carbon tube within which is a rod of magnesium, the space between tube and rod being filled by a wick of woodwool. The wicks of all four units protrude from their lower ends and are bundled together to form a pad, which rests in the electrolyte. The electrolyte itself is nothing more uncommon than tap water. The four carbon tubes are bound together with a wrapping of copper gauze so as to ensure the best possible contact.

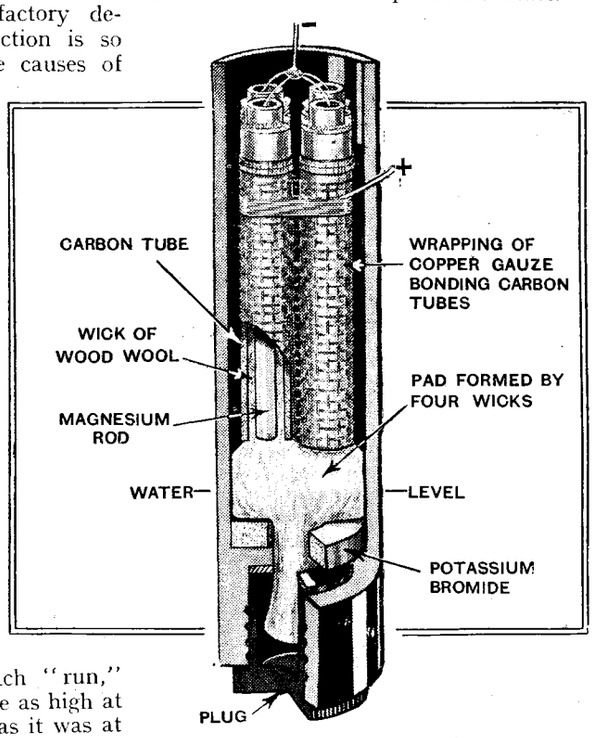


Fig. 2.—Drawing illustrating the construction of the Gordon cell and showing the four parallel units.

In the drawing a piece of potassium bromide is shown immersed in the water electrolyte and in contact with the woodwool pad. Actually, the cell will work without the potassium bromide, but its internal resistance is then on the high side.

One of the curious qualities of the Gordon cell is that it does not appear to polarise as other cells do. If water alone is used as the electrolyte the internal resistance remains more or less constant under load. The potassium bromide is not therefore, strictly speaking, the depolariser, though it unquestionably has the effect of reducing the internal resistance with a consequent increase in EMF under load and current delivered.

It will be observed that the electrolyte does not cover the electrodes as in other

Gordon Magnesium Battery—

cells; the Gordon cell will, in fact, not work properly if it is kept too wet. All the moisture required is supplied by the capillary action of the wicks.

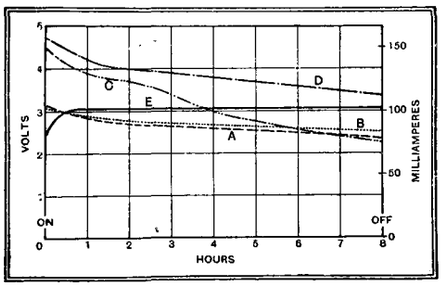
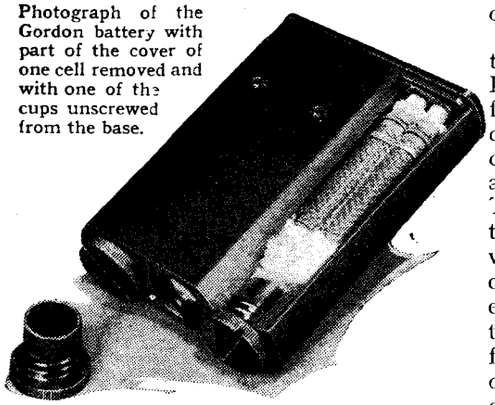


Fig. 3.—Discharge curves showing the performance of a selection of dry batteries of various sizes compared with the Gordon battery. The Gordon battery is represented by curve E. The weight and size of the batteries were as follows:—A, 7 oz., $3\frac{3}{4}$ in. × 2 in. × 1 in.; B, 11 oz., $3\frac{5}{8}$ in. × $2\frac{5}{8}$ in. × $1\frac{1}{4}$ in.; C, $9\frac{1}{2}$ oz. $3\frac{3}{4}$ × 3 in. × 1 in.; D, 15 oz., $3\frac{5}{8}$in. × 4 in. × $1\frac{1}{4}$ in.; E, 9 oz. $4\frac{3}{4}$ in. × $3\frac{1}{4}$ in. × $1\frac{1}{16}$ in.

The performance of the cell is most interesting, since it is so different from anything to which we are accustomed.

On open circuit the EMF is 1.6 volts, but under load it is initially only about 0.7 volt. And now the most curious effect illustrated in Fig. 3 is observed. When the cell is placed under a moderately heavy load—say 100 milliamperes for one measuring $\frac{11}{16}$in. diameter by $3\frac{1}{2}$in. in height—a steady rise in the EMF takes place for about half an hour. It goes on increasing until it reaches slightly over one volt per cell; it then settles down and remains steady at that figure under any reasonable load. The delay in the rise of the EMF to its steady figure may be very greatly reduced by doubling or trebling the initial load. If, for example, a 3-volt flash lamp bulb is connected to a 3-cell battery, such as that illustrated in the photograph, the glow from its filament is barely visible for an instant or two, but it then increases rapidly to its full brilliancy just as though a controlling rheostat were being moved from the "off" to the "full-on" position. The reason for the lag is not yet fully understood but it seems to be a thermal effect, for the cell becomes appreciably warm by the time that it has reached its full EMF.



Photograph of the Gordon battery with part of the cover of one cell removed and with one of the cups unscrewed from the base.

Another interesting feature of the Gordon cell is that since it does not polarise there is no recuperation. Hence its service life is equally good whether it is run continuously or intermittently. Fig. 3 shows the record of an eight hours' discharge of a 3-cell battery made up of cells of the size already mentioned under a load of 100 milliamperes.

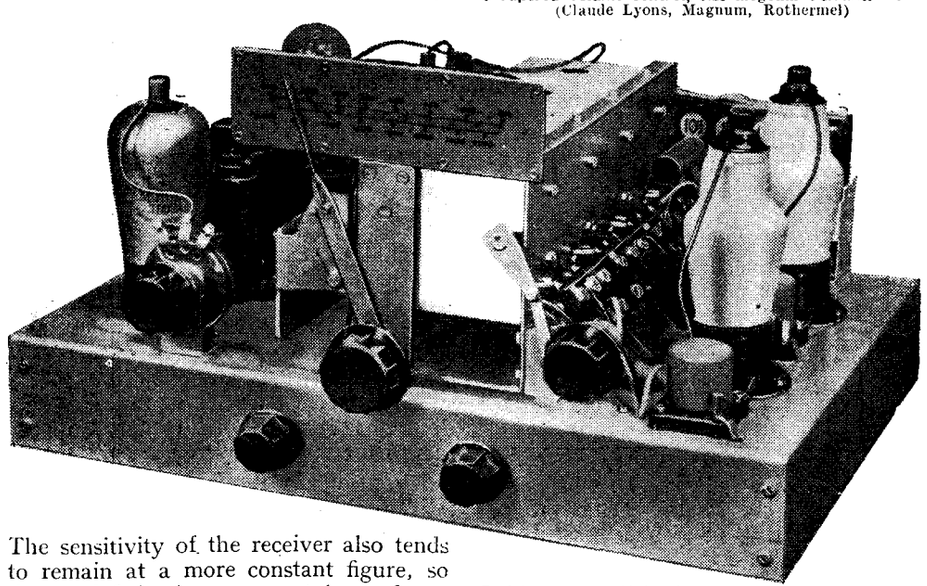
It will be seen that the EMF rises within half an hour to 3.1 volts, and that the curve becomes a perfectly straight line. If the battery is now rested its performance will be almost the same during its next run. It will take a little longer to reach its steady EMF, but again it will settle down at about 3 volts. Under the load indicated the battery supplies 100 milliamperes at 3 volts for nine days at eight hours a day, a total of 72 hours. A similar battery run continuously under the same load has a service life almost identical, though it may be actually a little longer than is the case in a continuous test.

In Next Week's Issue

The Permeability Battery Four

An Economical Long Range Receiver

THE advent of permeability tuning has removed one of the chief drawbacks of the straight set, namely, the wide variations in selectivity over the tuning range which are so inevitable when variable condensers are used for tuning.



The sensitivity of the receiver also tends to remain at a more constant figure, so that a definite improvement in performance is to be expected when this new form of tuning is employed.

Two HF stages embodying HF pentode valves are used in the Permeability Battery Four and they are both controlled for AVC purposes. The detector is a duo-diode-triode, which acts not only as a detector but provides also a stage of LF amplification and gives delayed AVC. The output valve is a double pentode of the quiescent push-pull type, so that while the receiver is both sensitive and capable of good volume reproduction it is economical in its demands on the HT battery. The selectivity provided by the four tuned circuits incorporated is adequate for all normal requirements and the quality of reproduction reaches a high standard, while the sensitivity is adequate for general long-distance reception, a number of Continental programmes being available in daylight.

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Permeability Tuner, 4-gang — **Varley BP101**
2 Bulbs, 2-volt 0.06 amp. (for dial lights) — **Bulgin "E"**
2 HF Chokes — **Wearite HFPJ**
1 HF Choke — **Bulgin HF8**
1 Rotary toggle switch, 4-point — **Bulgin S116**
1 Rotary toggle switch, DPDT — **Bulgin S114**
1 QPP Transformer, ratio 7:1 — **Lissen LN5306**
3 Valve holders, 7-pin — **Belling-Lee 1138**
1 Valve holder, 5-pin — **Belling-Lee 1136/S**
(Clix)
1 Tapered volume control, 0.25 megohm **Ferranti "P"**
(Claude Lyons, Magnum, Rothermel)

Resistances (1 watt type): **Amplion**
1 2,000 ohms
2 10,000 ohms
1 25,000 ohms
1 150,000 ohms
1 250,000 ohms
1 1 megohm
1 2 megohms
(Dubilier, Erie, Ferranti, Claude Lyons, Polar N.S.F., Watmel)

Condensers:
2 0.005 mfd. — **Dubilier 670**
1 0.001 mfd. — **Dubilier 670**
6 0.0001 mfd. — **Dubilier 665**
5 0.1 mfd. tubular — **Dubilier 4503**
1 0.04 mfd. tubular — **Dubilier 4503**
1 1 mfd. 500-volts D.C. test — **Dubilier BB**
(Bulgin, Ferranti, Graham Farish, Polar N.S.F., T.C.C., T.M.C. Hydra)

1 Stand-off Insulator — **Bulgin SW49**
(Raymart)
1 Three-pin Plug and socket panel — **Belling-Lee 1119**
1 GB Battery, 16½ volts — **Siemens**
1 pr. GB Battery clips — **Bulgin No. 1**
4 Terminals, ebonite shrouded, A.E. pick-up (2) — **Belling-Lee "B"**
3 Wander plugs, GB+, GB−1, GB−2 — **Clix "B"**
1 Battery cable, 5-way, 30in., with terminals and spade ends — **Belling-Lee**
1 Connector, 5-way — **Bryce**
6 lengths Systoflex, 2oz. No. 20 tinned copper wire, etc.
Screws: 30 6BA C/hd, ⅜in.; 10 6BA C/hd, ¼in.; 5 4BA C/hd, ⅜in., all with nuts.
Chassis No. 18 SWG aluminium, 14in. x 10in. x 2in. — **Peto-Scott**
Valves: 2 Cossor 210 VPT; 1 Mullard TDD2A; 1 Marconi or Osram QP21
Loud Speaker — **Rola FR7/PM60**

Single Side-Band Broadcasting

Some Official Views on a Matter of International Interest

REFERENCE has been made from time to time in *The Wireless World* to the advantages that could be obtained by single side-band broadcast working.

It is interesting to learn that the possibilities of this system of working are regarded as a matter of international importance, and that the U.I.R. (Union Internationale de Radiodiffusion) and the C.C.I.R. (Comité Consultatif International Radio) are both considering the subject, the former presumably in relation to the practical broadcasting use of the system and the latter in its strictly technical aspects. These facts arose out of a discussion at the Institution of Electrical Engineers of a paper by Mr. P. P. Eckersley on "Asymmetric Side-Band Broadcast Transmission," the principal participants in the discussion being representatives from the B.B.C. and Post Office.

The essential suggestion of the paper can be very easily explained with the aid of Fig. 1, in which (a) represents the conventional carrier and double side-bands (up to 10 kc.) resulting from the process of modulation, as explained in the articles in *The Wireless World*. The carrier is supposed to be modulated 100 per cent., so that its amplitude is twice that of the maximum in either of the side-bands, while the "shape" of the side-band is arbitrary but not untypical of the distribution of the various frequencies within the audio gamut.

If now the whole of the frequencies embraced in (a) are applied to a filter having the characteristics shown in (b), the result at the output of the filter (and throughout the remainder of the system) is as shown in (c). The filter of (b) is, of course, somewhat idealised, but is again not wholly untypical of something that can be attained in practice. The filter characteristics are assumed to be adjusted so that the carrier falls midway on the steeply falling side of the cut-off. As will be seen in Fig. 1, only one side-band is passed with little change. The other is almost entirely suppressed, and the parts of it which are not completely attenuated are complementary to the frequencies of the passed side-band which lie on the falling side of the cut-off (and are therefore somewhat attenuated). The result is thus to bring the total effect of these frequencies up to its full value. It will also be noted that the location of the carrier on this particular part of the characteristic attenuates the carrier so that it is of the same amplitude as the maximum in the side-band, that is to say, the carrier is modulated 100 per cent. by the single side-band. The general loss in amplitude is not great, and is easily restored by amplification.

Merits of the System

The advantages which are claimed for this arrangement are that it represents a method of single-side-band transmission that is attainable in practice and that the small amount of side-band which still exists on the cut-off side of the filter has the effect of eliminating or minimising what Mr. Eckersley called the "phase-modulation distortion" which exists with the single side-band. In the discussion it was suggested by a B.B.C. representative that this effect was quite incorrectly described and that it was simply the well-known difference which exists in the modulated envelope of single side-band as compared with double side-bands. Incidentally, it was surprising to find that no one drew the obvious comparison of the difference between heterodyne (single side-band), and tone modulation (double side-band), even if only to point out how the distortion of the heterodyne envelope had been successfully corrected in the many forms of heterodyne audio-frequency generator which ultimately give a pure sinusoidal output.

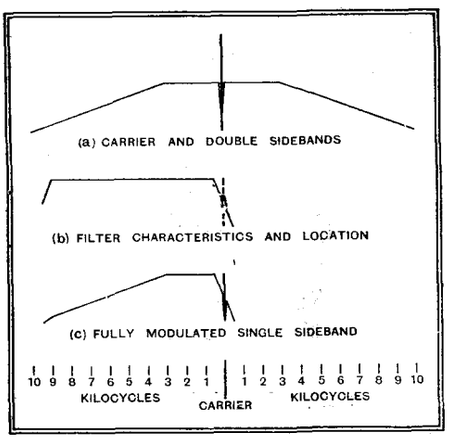

(a) CARRIER AND DOUBLE SIDEBANDS
(b) FILTER CHARACTERISTICS AND LOCATION
(c) FULLY MODULATED SINGLE SIDEBAND
10 9 8 7 6 5 4 3 2 1
KILOCYCLES
CARRIER
1 2 3 4 5 6 7 8 9 10
KILOCYCLES

Fig. 1.—Sketch illustrating the single side-band process.

The suggestions in Mr. Eckersley's paper were apparently thrown out with the idea of indicating one possible way of tackling a difficult subject. The method is, of course, intended to be used at the transmitter so that it radiates only one side-band, since this is the direct means of the more economic utilisation of the ether. By way of illustration, however, he quoted experiments in which the double-side-band transmission of the London Regional station had been converted *at the receiver* into a single-side-band effect by the process illustrated in Fig. 1, when the distortion was stated to be undetectable or negligible.

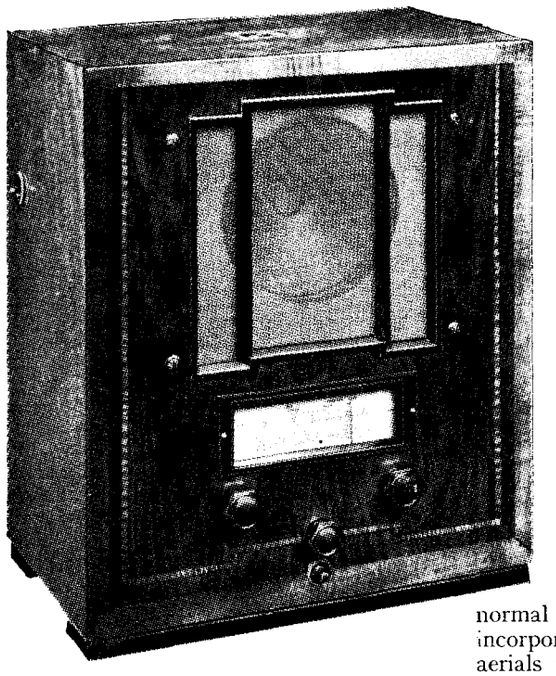
The most interesting points of the discussion were those put forward by Mr. Noel Ashbridge, the Chief Engineer of the B.B.C., who was responsible for the information given in the beginning of this article. Arising out of this international interest, also, he stated that the B.B.C. had already conducted experiments on the lines of those suggested and that the results had not been satisfactory. Only low values of modulation could be used; for example, 40 per cent. modulation gave hardly tolerable quality, and the modulation had to be 30 per cent. or less for acceptable quality. Experiments had been made on obtaining the single-side-band effect both at the transmitter and at the receiver, while other (e.g., Continental) broadcasting authorities who had tried single-side-band working had reported generally similar results. Unfortunately, no details were given of the types of receiver used, in particular, of the detector systems. In view of the difference of the envelopes mentioned above, this would appear to be a matter of the utmost importance. So far no completely reasoned explanation seems to be forthcoming for the practical failure of single-side-band methods. Perhaps it is not too much to hope that the B.B.C. may give a detailed account of their own and other work on a subject of such technical interest and importance in the future development of, at least, medium-wave broadcasting.

Mr. Ashbridge also returned to a statement which he has previously made in such discussions, namely, that most Continental broadcasting authorities are much less scrupulous than the B.B.C. about quality and about consistent deep modulation, frequently running into over-modulation. While this, of course, adds to the effective "range" of a station, it is not a helpful start on a subject in which quality appears to be bound up with low values of modulation.

Post Office Comments

Col. Angwin, of the Post Office, offered a few opinions which suggested that the way to single-side-band working was likely to be a somewhat slow one. His first comment was the reminder—unfortunately all too true—that broadcasting is not controlled by the technicians. At the same time he reminded the audience that further wavelength allocations for some parts of Europe (for example, the Balkans and Spain) were bound to be required, and that single-side-band working offered the only possibility of much extension. At the same time he clearly envisaged the slow progress suggested above, particularly in the matter of keeping the supply of receivers for public use abreast of progress. A very interesting suggestion was one intended to lead ultimately to the single-side-band and suppressed carrier method which has been used so successfully on fixed-frequency working on the Transatlantic telephony channel. Here the difficulty is that of *accurate* replacement of the carrier at the receiver, and the practical suggestion was for an interim stage in which the carrier was heavily but not wholly attenuated, and was used at the receiver for the regenerative production of a completely replaced carrier. The value of this intermediate stage was that it permitted receiver design to follow to this point as a step towards the final goal of generating the carrier locally at the receiver.

The discussion was interesting in revealing that the "official" side of broadcasting and broadcast control is alive to the advantages of single-side-band working in a very overcrowded European ether. The technical difficulties were indicated but were neither expanded nor elucidated, and the administrative difficulties that might follow on even perfect technical solutions were not touched at all. But this is perhaps why broadcasting is not controlled by technicians!



H.M.V. Model 340

A Universal Superheterodyne with an Interesting Reflex Circuit

FEATURES.—***Type.***—*Table model superheterodyne for AC or DC mains.* ***Circuit.***—*Heptode frequency changer—combined IF amplifier, second detector and LF amplifier — pentode output valve. Half-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume. (3) Waverange. (4) Mains on-off switch.* ***Price.*** *— 11½ guineas.* ***Makers.*** *— The Gramophone Co., Ltd., 98/108, Clerkenwell Road, London, E.C.1*

THIS receiver works equally well on DC or AC mains, and has been designed for supply voltages between 195 and 255 volts, and, in the case of AC mains, for frequencies from 25 to 60 cycles. It should appeal particularly to those who may be moving into another district in the near future, or in cases where there is a possibility that the supply may be changed from DC to AC. From the point of view of design and workmanship the set bears the unmistakable stamp of H.M.V. quality, and it is housed in a compact cabinet finished in various tones of polished walnut veneer. The price is very reasonable, and an ingenious reflex circuit is largely responsible for the reduction of manufacturing costs.

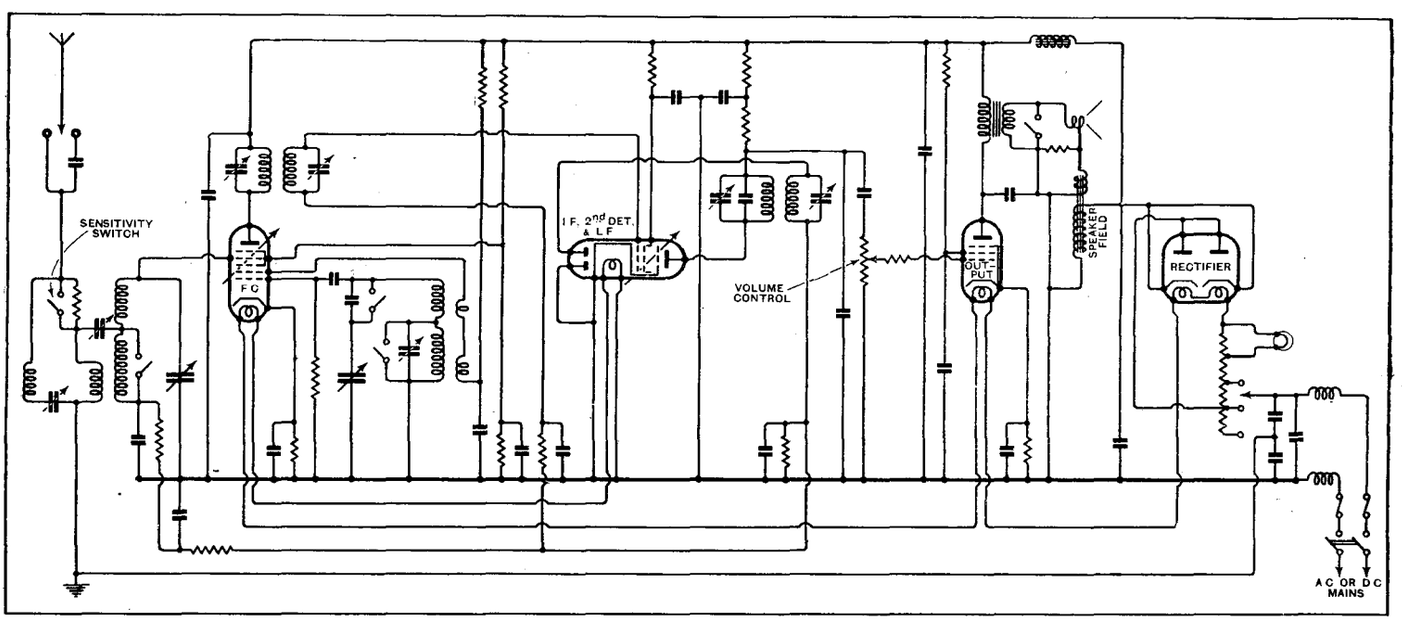
Apart from the rectifier only three valves are used, but the functions which they perform give a performance which could only be obtained with six or seven of the simple valves of a year or two ago. There are two aerial terminals, one for normal outdoor aerials and the other incorporating a series fixed condenser for aerials of abnormally high capacity. A single tuned input circuit is coupled to the aerial by a combination of capacity and inductive coupling designed to give uniform sensitivity throughout the waverange. The aerial circuit also includes a tuned acceptor adjusted to the IF frequency of 456 kc/s and designed to by-pass morse interference, which might otherwise be picked up and amplified at that frequency. A sensitivity control is also incorporated at this point and consists of a series resistance which may be short-circuited at will.

Detector, IF and LF Amplifier

The usual oscillator coils are associated with the heptode frequency-changer and the IF transformer, which is litz-wound, feeds into the control grid of the second valve in the circuit, which is a double-diode-pentode. The first function of this valve, therefore, is as an IF amplifier, and a second IF transformer is connected in its anode circuit. The secondary of this transformer feeds one of the diodes, the other being shorted to the cathode. The rectified signal developed across the diode load is then returned to the control grid of the pentode where it is amplified and the increased output is developed across a resistance immediately above the IF transformer in the anode circuit. The alternating component is passed to a resistance capacity network incorporating the volume control, to the grid of the output pentode, while the amplified DC component is filtered and arranged to supply the AVC control bias to the frequency-changer and the control grid of the second valve in the circuit.

The field of the energised moving coil loud speaker is connected across the HT supply and a hum-bucking coil is included to neutralise mains hum. A muting switch connected across the primary of the output transformer is associated with the waverange switch to obviate switching noises when changing from medium to long waves.

The rectifier valve has its two anodes

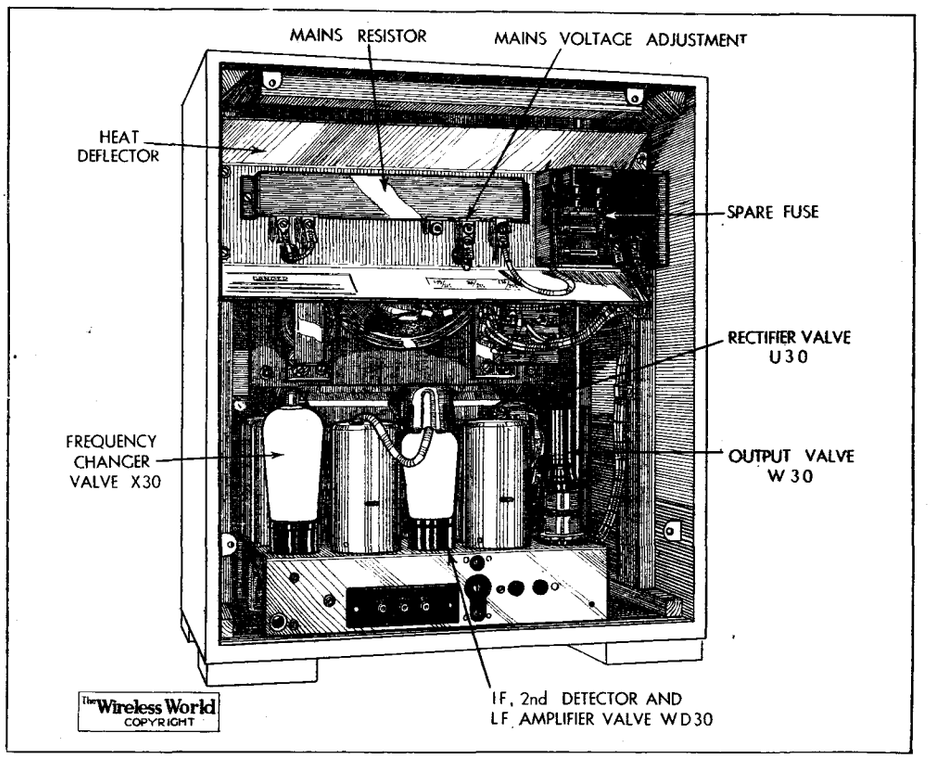


The circuit is notable for the employment of a double-diode-pentode valve as a combined IF amplifier, second detector and first LF amplifier.

H.M.V. Model 340—

connected together and functions as a half-wave rectifier on AC mains and as a low resistance on DC supplies. The mains switch is of the double-pole variety and fuses are included on both leads. In addition there is a filter consisting of a network of chokes and condensers designed to stop HF interference from entering the set through the mains leads.

There are the usual three principal controls of tuning, volume and waverange, but the on-off switch is mounted separately on the left-hand side of the cabinet instead of being incorporated in the volume control as is usual. Immediately below the centre tuning control is a press button, which gives alternative high or low sensitivity. When receiving the local station the low sensitivity should be used, as otherwise there is a tendency to overloading in one of the earlier stages which gives apparent double hump tuning.



The mains resistance is located in a metal shield which is arranged to establish a cooling stream of air through the interior of the cabinet.

Performance

It is a tribute to the automatic volume control that the volume, not only on the local, but on the more powerful Continental stations, is unaffected when the sensitivity switch is pressed, while the overall magnification is such that a large number of foreign stations can be received on the normal outdoor aerial with the receiver in its least sensitive condition. Under these conditions there is absolutely no background noise between stations, and with the high sensitivity the level of background noise is noticeably less than that usually associated with universal receivers of this type.

Owing to the high intermediate frequency, second-channel whistles are absent on the medium waveband. One or two could be detected on the long waves, the principal one in the London district being adjacent to Kalundborg; but, generally speaking, interference from this cause is not likely to be troublesome.

In the absence of an input band-pass filter the long-wave selectivity is not sufficient to receive the Deutschlandsender as a satisfactory programme unless one or both of its neighbouring stations is not modulating. On the medium waveband only one channel was lost on either side of the Brookmans Park National transmitter, but three channels on either side of the normal setting were occupied by the spreading of the Regional programme when received in Central London.

Although the loud speaker is of small diameter the bass response is excellent and the reproduction generally is notable for its full body of tone. There is no tone control, neither is there a tuning indicator, so that the quality of reproduction is dependent to some extent on the skill with which the tuning control is handled. Exact tuning gives best results on organ music and other transmissions which are rich in the lower frequencies, but very slight mistuning improves the top response for the reproduction of speech and other transmissions, such as dance bands, which call for clarity and brightness of tone. The correct setting will, however, be found instinctively, and deliberate mistuning, if carried too far, will only result in hardness of tone.

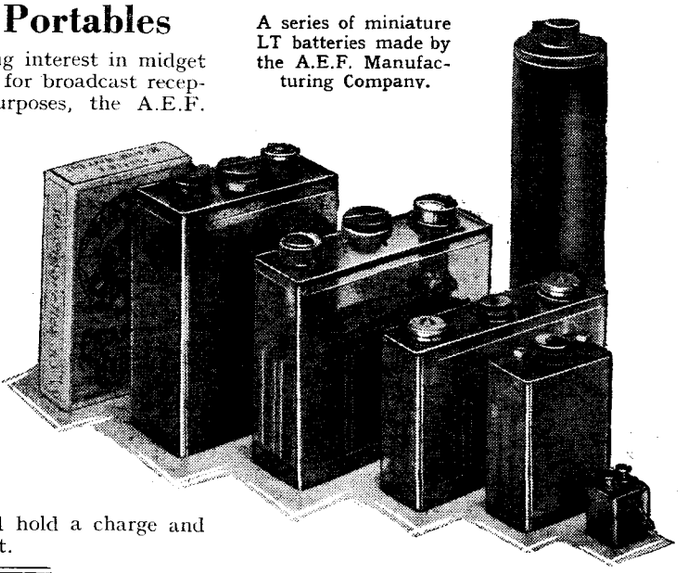
No provision has been made for external pick-up leads, and a specially designed safety plug is arranged so that it must be removed before access can be obtained to the interior of the set.

The heat generated in the mains resistance is prevented from entering the cabinet by a metal deflecting cowl, which also promotes the establishment of regular convection currents. The terminals for mains voltage adjustment are accessibly mounted on the resistor element and the fuses are placed immediately below the mains plug. Following the practice of manufacturers of car electrical equipment a spare fuse is to be found in clips adjacent to the circuit fuses.

In conclusion, we would congratulate the makers on the accuracy of the horizontal tuning scale, which is calibrated in wavelengths and gives the settings of all the important British and Continental stations.

For Real Portables

IN view of the growing interest in midget receiving sets, both for broadcast reception and for other purposes, the A.E.F. Manufacturing Company, of Ohmic Works, Queensway, Ponders End, Middlesex, are specialising in the production of miniature accumulator cells of all types. A few of the patterns already manufactured are shown in the accompanying illustration; in spite of their small size, all the cells are for serious work except, perhaps, the smallest, although even this will hold a charge and deliver a limited output.



A series of miniature LT batteries made by the A.E.F. Manufacturing Company.

Pocket Conversion Tables

A handy set of tables for converting wavelength in metres to frequency in kc/s, or *vice versa*, has just been issued by H. C. van Rood Technical Publications, of 93, Berrylands, Surbiton, Surrey, at 1s. 6d., post free. The tables are bound (in cloth) in a convenient size for the waistcoat pocket.

Listeners' Guide for the W

ON PARADE. Philip Ridgeway and his "Parade" rehearsing in a B.B.C. studio. They return to Broadcasting House at 8 p.m. in the National programme on Monday next (May 20th) and at 7 p.m. (Regional) on Tuesday. The "stars" will include Delys Hendie and Hugh Dempster.

SUMMERTIME PROGRAMMES.

JUST enough of summertime's approach is evident in the week's programmes to give them a refreshing flavour; as summer advances a hint of staleness may supervene unless the B.B.C. has profited by experience and can keep the mixture bubbling till the "Proms" season starts.

THE MICROPHONE AT LARGE.

ONCE again it is the Midland microphone that takes us into the open in another "Microphone at Large" feature this evening (Regional), when the ancient port of King's Lynn will be visited. So far Owen Reed, who organises these tours, has exercised a fine discrimination in the choice of localities, and there is no reason to doubt that King's Lynn will offer as picturesque a story as any of its predecessors in the series.

HILL CLIMB THRILLS.

PRACTICALLY all the thrills of a motor hill climb will be available to listeners during tea-time to-morrow (Saturday) when Mr. F. J. Findon and Major Vernon Brook will give a running commentary in the Regional programme on the International Open Hill Climb for racing and sports cars at Shelsley Walsh. This will be the thirtieth anniversary of the event, which is organised by the Midland Automobile Club, over £1,000 being given in prizes. Track racing drivers from all over the world compete. Last year Whitney Straight, the young American sportsman, beat Hans von Stuck's record of 42⅘ seconds, which had stood for two years. Mr. Straight's record was 42 seconds dead.

Shelsley is situated about twelve miles north-west of Worcester. From the foot to the summit is over 1,000 yards, with a gradient of 1 in 8.907. On either side of the narrow, twisting road are steep banks.

A RIDGEWAY JUBILEE.

PHILIP RIDGEWAY and his "Parade" return to Broadcasting House at 8 p.m. in the National programme on May 20th and at 7 p.m. in the Regional programme on May 21st.

Philip Ridgeway states that this broadcast marks the twenty-fifth anniversary of his début on the stage, so it is somewhat of a Jubilee occasion.

Since their last broadcast the Parade have visited many provincial theatres. Next week they will come to the microphone with a cornucopia of original material.

30-LINE TELEVISION

Baird Process Transmissions.
Vision 261.1 m.; Sound, 296.6 m.

MONDAY, MAY 20th.
(No transmission).

WEDNESDAY, MAY 22nd.
11.15—12 p.m.

Leonard Henry, with Lorna Jermaine (specialist dancer) and Jean and Joan Ormonde (The Singing Dancing Sisters).

MODERN GERMAN MUSIC

THE works of two young German musicians, Heinz Schubert and Gustav Schwickert, will be heard in a programme broadcast by Hamburg and all German stations on Thursday next, May 23rd. On the same evening Radio-Paris will broadcast a concert by the National Symphony Orchestra, and the soloist will be Lovano, singing Milhaud's "Liturgies contadines" at 10.30.

RICHARD II.

MANY Shakespeareans consider that "Richard II" is the finest of the historical plays, and there should be a large audience for the broadcast production by the Old Vic Shakespearean Company of "Richard II" in the National programme next Sunday afternoon.

Maurice Evans appears as King Richard II, Alan Napier as John of Gaunt, Abraham Sofaer as Henry Bolingbroke and Richard Warner as Harry Hotspur. The only female rôle is that of Queen to Richard II, to be taken by Vivienne Bennett.

The producer is Henry Cass, and Lance Sieveking, long schooled in the tricks of the microphone, will supervise the broadcast.

"BADGER'S GREEN."

ALL the drowsy fragrance of a summer afternoon should filter through the microphone with the broadcasting of R. C. Sheriff's "Badger's Green" on Monday (Regional, 8) and Tuesday (National, 8).

The action of the play takes place in a small country village on a day in late summer, the atmosphere redolent of cricket pitches, refreshments in the marquee and bucolic disputations. In the broadcast version Horace Hughes will take the part of Dr. Wetherby and Joan White will appear as Miss Rawlinson.

MUSIC OF RUTLAND BOUGHTON

RUTLAND BOUGHTON'S music has a mysterious and romantic quality of its own. In the Regional programme on Sunday evening an hour will be devoted to selections from his music dramas by the B.B.C. Midland Orchestra. The works drawn upon will include

REGINALD KING, whose orchestra is a regular and frequent contributor to the B.B.C.'s light musical programmes.

"Agincourt," "The Lily Maid" and "The Immortal Hour," and the soloists include Frank Titterton (tenor), Geoffrey Dams (tenor), and Eveline Stevenson (soprano).

A. J. ALAN.

A. J. ALAN comes to the microphone on Sunday evening in an appeal on behalf of the St. Marylebone Health Society, 14, Salisbury Street, N.W.8. The doyen of broadcast story-tellers may be expected to present his appeal in an original form.

Week

Outstanding Broadcasts at Home and Abroad

CONDUCTING AT TWELVE.

KOUSSEVITZKY, who to-night conducts the second concert in the London Music Festival (National, 8.30) has a remarkable personality. He has been conducting since he was twelve and for some years had an orchestra of his own in Russia. Since 1924 he has had charge of the Boston Symphony Orchestra. His own instrument is the double bass.

To-night's programme by the B.B.C. Symphony Orchestra includes the Beethoven "Eroica" Symphony and Symphony No. 2 in D by Sibelius.

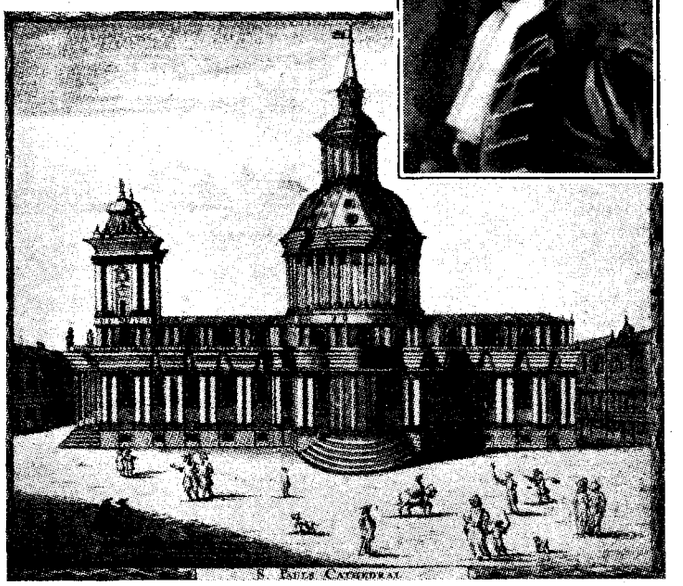
THE BRITISH ISLANDERS.

TO-NIGHT (Friday) there is an interesting feature for listeners who enjoy satire, for in the National programme Archibald Lyall, a young Oxford wit who scored a success with his book, "It Isn't Done," will pillorise some of our national foibles. For this purpose he will presume himself to be a Martian who has just returned to Mars from a visit to these islands, and describe some of the middle-class taboos and peculiar customs. This will be the first talk of a series which are to be known as "Among the British Islanders."

OPERA

OPERAS and Operettas are offered in embarrassing profusion by the Continental stations. To-night (Friday) Monte Ceneri is relaying Act I of Flury's two-act opera, "Die helle Nacht" from 8 to 9 o'clock, while Act II will be heard from Beromunster from 9.20 to 10.30, played by the Berne Municipal Orchestra.

To-morrow (Saturday) there is Verdi's "Falstaff," to be heard from 8 to 10 p.m. on records from Monte Ceneri, performed by the caste of the Scala, Milan. As an alternative there is Weinberg's opera, "Schwanda," to be broadcast at 8 o'clock by Oslo.



"SIR CHRISTOPHER WREN," the successful biographical play by Whitaker-Wilson, first broadcast in October, 1932, will be heard in the National programme at 8 on Thursday next (May 23rd), Carleton Hobbs taking the part of Wren. Above is an interesting drawing of St. Paul's Cathedral as Wren originally planned it. Inset: Kneller's portrait of the architect.

OPERETTAS

ON Tuesday next Paris PTT and all French stations, except Radio-Paris, will relay Offenbach's opéra bouffe, "Geneviève de Brabant," from the Conservatoire, performed by the National Orchestra conducted by Inghelbrecht. The same evening at 9 Warsaw broadcasts Moniuszko's one-act opera "Verbum nobile," which will be relayed by Berlin (Funkstunde).

Millöcker's three-act operetta, "Der Bettelstudent," comes from Munich to-morrow (Saturday) from 8.10 to 10 p.m., and during the same period the Leipzig Symphony Orchestra and Station Choir will give operetta music.

GRAND OPERA will again be relayed from Covent Garden next week. Act III of "Tristan and Isolde" will be heard on Monday (National) and Act II of "The Italian in Algiers" on Tuesday (Regional).

"TOO HUMOROUS . . ."

"Too humorous to be properly appreciated" was the verdict passed by the French critic, Henry Prunieres, on the works of Satie, whose "Gymnopédies," orchestrated by Debussy, will be heard in the concert by the Gooisch Symphony Orchestra broadcast from Brussels No. 1 to-morrow evening (Saturday) at 8 o'clock. Satie, who had an English mother, was born at Honfleur in 1866, and studied at the Paris Conservatoire. His bold harmonic combinations had some influence upon Debussy, so perhaps we may regard him as the originator of the "modern" style. "Gymnopédies" should be worth tuning in. THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, MAY 17th.

Nat., 8.30, London Music Festival Concert—II. Conductor: Serge Koussevitzky.
Reg., "The Microphone at Large," ¶B.B.C. Theatre Orchestra with Jan van der Gucht (tenor).
Abroad.
Milan, 8.50, Operetta, "La Citta Rosa" (Lombardo-Ranzato).

SATURDAY, MAY 18th.

Nat., Sadler's Wells Gala Night: Act II of "Die Fledermaus" (Johann Strauss).
Reg., American Half-Hour—VII. ¶Jubilee Party. ¶Ambrose and His Embassy Club Orchestra.
Abroad.
Berlin (Deutschlandsender), 8.10, "A Merry Week End."

SUNDAY, MAY 19th.

Nat., Alfredo Campoli and His Orchestra. 5.30, Richard II (Shakespeare). ¶Bournemouth Municipal Orchestra with Dale Smith (baritone).
Reg., Hanwell Silver Prize Band. ¶Music of Rutland Boughton.
Abroad.
Brussels No. 1, 9.15—12, Symphony Concert from the Universal Exhibition.

MONDAY, MAY 20th.

Nat., "Chords that Matter"—VI, by Sir Walford Davies, C.V.O., 8, "The Ridgeway Parade," ¶"Tristan and Isolde" from Covent Garden.
Reg., 8, "Badger's Green." ¶Edward German Programme by B.B.C. Orchestra (E).
Abroad.
Kalundborg, 10.25, Bach and Mozart Concert by the Radio Orchestra.

TUESDAY, MAY 21st.

Nat., 8, "Badger's Green." ¶"Freedom" by the Rt. Hon. Sir William Jowitt.
Reg., 7, "The Ridgeway Parade." ¶The Music of Lalo: B.B.C. Midland Orchestra. ¶"The Italian in Algiers," from Covent Garden.
Abroad.
Paris P.T.T., 8.30, Opera: "Genevieve de Brabant" (Offenbach) from the Conservatoire.

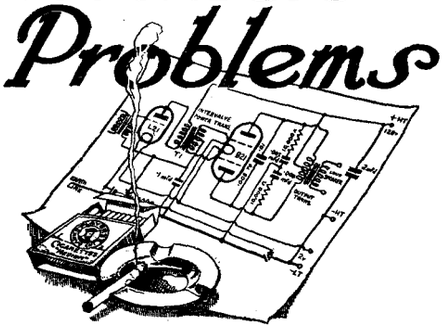
WEDNESDAY, MAY 22nd.

Nat., "Chateau de Madrid." 8.30, London Music Festival Concert—III. Conductor: Koussevitzky. ¶Roy Fox and his Band.
Reg., Old French Music by the Georgian Trio. ¶"Cam Houses to Shunnor Fell"—Northern feature programme.
Abroad.
Strasbourg, 8.45, Symphony Con- from the Orangerie.

THURSDAY, MAY 23rd.

Nat., 8, "Christopher Wren." ¶Walford Hyden and his Magyar Orchestra.
Reg., Three Valleys Festival Concert from Mountain Ash. Conductor: Malcolm Sargent. ¶Soft Lights and Sweet Music.
Abroad.
Warsaw, 9, Concert by the Symphony Orchestra.

Readers' Problems



THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Superheterodyne Selectivity

A CORRESPONDENT, discussing the relative merits of superheterodyne and straight set for his own particular needs, seems to imagine that, so far as selectivity is concerned, it is only a matter of the number of tuned circuits; in a superheterodyne, of course, a relatively large number of such circuits can be employed economically, as those in the IF amplifier do not have to be retuned for every station.

There is more in it than that. Apart from the fact that a large number of circuits can practically and inexpensively be used in a superheterodyne, an actual gain of selectivity is obtained by the process of frequency changing. Another point in favour of the superheterodyne, as compared with the ordinary straight set, is that the selectivity of the IF amplifier which provides most of the overall selectivity remains absolutely constant, irrespective of the wavelength to which the controllable signal-frequency circuits are tuned. This is by no means the case in a straight set, where high-note loss, due to the tuned circuits, may vary by as much as 20 decibels or so from one end of the scale to the other.

Vibratory HT Generators

WE are asked to give a reference to published information on the construction of a vibratory HT generator for "stepping up" the voltage of a small LT battery to a value of 150 volts or so for the supply of anode current to a three-valve receiver.

Unfortunately, there seems to be no published information on this subject. Indeed, the construction of these devices is not entirely straightforward, and, in particular, the mechanical problems associated with the tuned vibratory mechanism are by no means simple.

However, our querist may be interested in the arrangement shown diagrammatically in Fig. 1, which was put forward by a reader of *The Wireless World* some months ago.

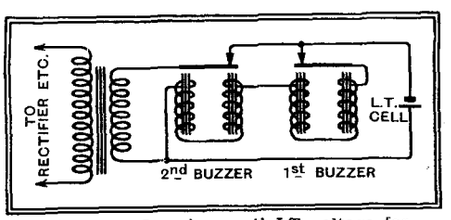


Fig. 1.—"Stepping up" LT voltage for HT supply.

As will be seen, this device makes use of a pair of buzzers, and the advantage of the particular scheme of connections advocated is that the resistance of the buzzer coils is not in series with the transformer.

The correspondent who originally evolved the circuit states that it gives perfectly satisfactory results, and, though it is desirable that both buzzers should have the same natural frequency of vibration, it is found that, with care, ordinary cheap buzzers may be suitably adjusted.

Intermediate-frequency Interference

AN IF amplifier of modern design, even if it consists only of a single stage, is a highly sensitive device, and so it is understandable that serious interference will be caused if unwanted signals of the frequency to which it is tuned are applied to its input terminals. Fortunately, the filtering effect of the preselection and frequency-changing circuits is usually effective in preventing such interference, but occasionally it is experienced, particularly by those who are unfortunate enough to live close to a wireless telegraphy station operating on a wavelength corresponding closely to the intermediate frequency of the receiver. This interference can usually be recognised by the fact that it is practically unaffected by the operation of tuning and interferes with reception of all stations to a sensibly equal extent.

A reader who describes precisely these symptoms is undoubtedly being troubled by direct pick-up of interference by his IF amplifier, and we suggest, in the first place, that he should try the effect of retrimming the various IF circuits to a slightly different frequency. However, as the set is working extremely well in all other respects, he may be unwilling to interfere with the adjustments that have already been carefully made, and as an alternative it is well worth while trying the effect of an ordinary type of wavetrap, tuned to the intermediate frequency and inserted in the aerial circuit.

Re-ganging Needed

WHEN the application of reaction fails to have its usual effect in increasing signal strength, it is reasonable to assume that the circuit affected is not accurately tuned to the incoming signal. In such circumstances, indeed, an actual reduction in volume is the result to be anticipated. In a typical ganged receiver the presence of this effect suggests that the detector grid circuit is not tuned to the same wavelength as the remaining circuits.

The user of a two-HF set, of which the reaction control is working—or, rather, failing to work—in the manner discussed, would be well advised to try the effect of retrimming, and he will probably save himself trouble by first adjusting the detector grid-circuit trimmer.

The Wireless World
INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in connection with receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be by letter to *The Wireless World* Information Bureau, Dorset House, Stamford Street, London, S.E.1, and must be accompanied by a remittance of 5s. to cover the cost of the service.

Personal interviews are not given by the technical staff, nor can technical enquiries be dealt with by telephone.

Adding a Tweeter

A CORRESPONDENT, who wishes to add a crystal high-note speaker to his receiver, is apparently under the impression that in doing so he will become involved in complicated matching problems, and, moreover, that it will be difficult to switch the tweeter out of circuit on occasions when it becomes desirable to restrict high-note response through interference or any other causes.

Actually, the addition in question is quite a simple matter, and the ordinary method of connection, as shown in Fig. 2, overcomes both the objections raised.

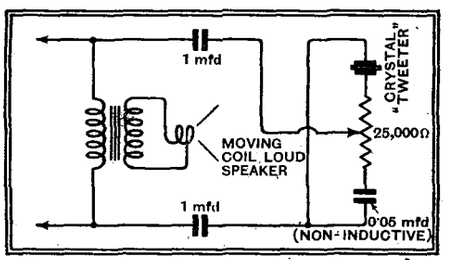


Fig. 2.—Connection of a high-note speaker to an existing speaker.

By adjustment of the potentiometer shown in the diagram the effect of the tweeter in strengthening high-note response may be fully controlled.

Excessive High-note Response

THE constructor of a resistance-coupled LF amplifier is disappointed to find that reproduction is excessively high-pitched—he describes it as "reedy"—and, moreover, that the overall amplification appears to be extremely low, considering the fact that three stages are employed. Values of coupling components throughout are virtually those advocated in the various published articles and also employed in successful receivers described in this journal.

Components have been tested, as far as is possible with limited equipment, and appear to be in order.

High-pitched reproduction and low amplification is almost always traced, in an RC amplifier, to the use of a coupling condenser of excessively low capacity, or more often to one with an internal disconnection. It is surprising how such an amplifier will go on working after a fashion when one of the stages is virtually coupled to the preceding one by nothing more than the stray capacities present in the wiring, etc.

We assume, therefore, that one of our querist's coupling condensers is at fault; he has probably found the usual difficulty in testing them, but, as it is most unlikely that both are defective, a comparative test could be made without much difficulty.

BROADCAST BREVITIES

By Our Special Correspondent

Henry Hall: Film Star

"MUSIC Hath Charms" is the title tentatively chosen for a film in which Henry Hall is to appear as the hero with the members of his band manfully supporting him through thick and thin. The leading lady has not yet been selected.

Some of the shots are being taken this week at the British International Pictures studios at Elstree. I hear that the film will be of the long feature type, not one of those tantalising little "shorts" usually reserved for news theatres.

It will be released in December.

Summer-time Shots

Further shots will be taken in the week beginning June 3rd, when substitutes for Henry Hall's band in the B.B.C. programmes will be Maurice Winnick, Geraldo and his Gaucho Tango Orchestra, and Marius B. Winter.

A allwch chwi siarad Cymraeg?

WHAT a chance, look you, was missed last week by Welsh-speaking people who failed to notice the B.B.C. advertisements announcing several vacancies at Cardiff, Bangor, and Swansea! Applications for the posts of Programme Director, Variety Assistant, Feature Programme Assistant, Announcer, etc., had to reach Broadcasting House by May 11th, and one of the stipulations was that intending applicants must be Welsh speaking.

Learning Welsh

I wonder whether many Englishmen applied. It is on record that George Borrow, who was as English as the Bank of England, took the trouble to learn Welsh before holiday-making in the Llandudno district, but his example is not often followed except, perhaps, by English listeners tantalised to the point of madness by the Welsh talks from Droitwich.

Daventry Gets a Move On

THE satisfied smile on the face of Mr. Cecil Graves, B.B.C. Empire Director, when, with his wife, he left Southampton last week on the "Aquitania" on a holiday trip to Canada, may have been due to the impending announcement that the Daventry short-wave station is to have two additional transmitters of higher power than those now in use.

There will also be extensions to the aerial system based on the data collected in the experimental work carried out at Daventry during the past two and a half years.

Three Transmitters

When the two new transmitters are working, the two existing plants will be combined to form one of higher power, making available three transmitters in all. These changes will, of course, involve important building extensions, which are to be started at once.

The new developments will constitute a conclusive answer to those critics who have been condemning the Corporation for its alleged apathy towards Empire listeners.

Double Power

No doubt reception of the existing stations has, in many parts of the world, cut a poor figure beside that of the Dutch, French, and German world stations, but if, as I understand, the present power at Daventry will be more than doubled, the "furriners" will have to look to their laurels.

Advice for Newfoundland

After a stay in Canada Mr. Graves will spend some weeks in Newfoundland advising the Government in the establishment of a local broadcasting service.

Sir Henry Again

SIR HENRY WOOD'S decision to conduct the forty-first summer season of Promenade Concerts at the Queen's Hall will be hailed with joy by all who realise how much the personality of Sir Henry has played in building the "Proms" tradition.

The 1935 season will run from Saturday, August 10th, to Saturday, October 5th, and, when the concert comes to its triumphal finish with Sir Henry Wood's famous Fantasia of British Sea Songs, we shall all wish him "Many Happy Returns."

All the concerts will be broadcast.

Shock for Malta Listeners

THE alarming appearance of the Empire programmes on the medium waveband recently aroused excitement among listeners in Malta. According to a correspondent, the local experts were hurriedly summoned, but only one or two who were "in the know" could explain the phenomenon.

However, the ether had not set to work on a new theory, for it was found that "Radio Malta" was testing with a relay of the Daventry short-wave stations. "Radio Malta" is actually a naval station temporarily turned over to radio telephony to relay the Jubilee programmes. In spite of obvious limitations, the quality is quite good.

Demand for a "Local"

Incidentally, a permanent "Radio Malta" is much sought after by the Island residents, for, though the Empire programmes, and even those from Droitwich, are obtainable, the results can be very indifferent at times, and when a sensitive set is used interference from Service stations and local shipping can be very disheartening.

The residents have, however, adopted the fair-minded but, in my opinion, mistaken view that a local broadcasting station would cause interference with Service communications in the district. The choice of a suitable wavelength should surmount trouble of this kind just as in London or Paris.

Out of the Movement

"NOT to be possessed of a receiving set to-day," says "Egyptian Radio," "is, in a word, to be twelve years behind the news, to be behind the times, to be 'out of the movement,' to be turning the back to one of the most inexhaustible sources of pleasure in this modern world."

The Derby

THE Derby will be broadcast on June 5th. Mr. R. C. Lyle will again describe the race from a box on the top tier of the new stand. There is only one commentator in this broadcast, whereas in the National, owing to the usual obscurity, there are two. This year the new B.B.C. recording van will be going to the course to pick up sound records of the crowds, the racing, and the festivities which may give added colour to the news bulletin of the day.

Covent Garden and Television

THIRTY-LINE television is having a raw deal these days. The scene was set for the usual transmission on Monday next, but it was discovered that the Covent Garden relay of "Tristan and Isolde" would overrun the television period. And so the poor dogs had none. . . .

ARE YOU READY? Sir Henry Wood gives the note on his patent tuning fork before an orchestral recording in the Decca studios. Sir Henry has decided to conduct the forty-first summer season of the "Proms" in the Queen's Hall, starting on August 10th. All the concerts will be broadcast.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

High Fidelity

THE article by "Cathode Ray" on "High Fidelity" in the issue for May 3rd, 1935, is extremely interesting to us as public address engineers. He accurately describes our own experience in trying to give the public balanced reproduction. We have been told that it lacks "mellowness," this after we have exerted all endeavours to obtain microphones, pick-ups, amplifiers, and loud speakers giving as near as possible something like the original. The criticism applies chiefly to gramophone reproduction, and in some cases to the amplification of vocalists and relayed music.

A recent client who has had an installation a month acknowledges that there is nothing wrong with it, but he has seen a tone control used on another installation, and would like one fitted in order to fake vocalists' voices. We don't consider tone controls are necessary on a good-quality amplifier used purely to amplify vocalist and orchestra.

We know we are not the only firm who have to contend with this distorted view of what music from a loud speaker should sound like, which is retarding the sales of high-quality radio receivers as well as amplifiers.

Were it possible for all prospective buyers of radio to have a high-fidelity receiver for a month, as was the case of the gentleman who bought one of your advertiser's receivers and was then convinced, perhaps the general appreciation of good reproduction would become more "linear."

Strangely enough, the faithful reproduction of speech cannot be too good for the same critics on the same apparatus, and the general remark is that it must be a "good microphone," which goes to show how little the public think of the "good amplifier" and "good loud speakers" which are doing most of the work. In the case of a radio receiver it is the "good loud speaker" that gets the praise.

We often wonder is it worth while endeavouring to give the best; but, since we cannot listen to an "absent top" and a "faked bottom" ourselves, we still persist, and live in the hope that some day good-quality reproduction will be the ultimate aim of every "good" listener.

p.p. HOLIDAY AND HEMMERDINGER.

Manchester, 3. J. S. HOLIDAY.

Wireless World Quality Amplifier

I HAVE just completed the building and testing of *The Wireless World* QA Receiver and Amplifier, and cannot refrain from congratulating you on such an outstanding piece of equipment. I have been a reader of *The Wireless World* for more years than I care to remember, and have built many of your previous designs with success, but this latest one eclipses them all. For the benefit of other readers who may be contemplating the building of this QA outfit I may say that my "Local" Station is North Regional, a good hundred miles distant, yet I am easily able to overload the output valves on this station without using reaction. True, I have a fair aerial and earth system, but what enthusiast hasn't. Many of the more powerful Continentals came in almost as loud as North Regional, and with supreme quality. Now as regards selectivity, by judicious use of the reaction control I get as much of this as I want, and as an instance I am able to receive Cologne after dark clear of North Regional and almost as loudly, though of course with some unavoidable loss of "Top," but the quality is still better than any commercial receiver can show on a similar test, the separation in this case being, I believe, 10 kc/s. So much for sensitivity and selectivity. Now for the star turn—quality! It so happens that I have had a fairly thorough musical education and am possessed of a keen and critical ear. Suffice it to say that for the first time in my life I have, with this receiver, heard the nearest approach to *real string tone* that I have ever heard emanating from a loud speaker, and this, too, without any "Tweeter," my speaker being an RK Senior (Energised) and set flush in the wall of the room, thus achieving a practically infinite baffle without baffle vibration or box resonance. To show off the quality to advantage one has to choose carefully one's transmission, outside relays become obviously inferior to studio transmissions; indeed, one can conceive the B.B.C. having to improve the quality of many of their transmissions should the QA become popular, as it is now an easy matter to detect whether the mike used is modern, and some of the efforts of the effects department become obviously elementary. To sum up, the quality is most marked on string tone, brass instruments, and transient sounds as cymbals, triangles, etc., the solo pianoforte, too, being really beautifully reproduced. One appears to capture, too, a large part of the "atmosphere" of the concert hall, the many incidental sounds such as key clicks coming through, as well as the real "growl" of the double basses, which too often sounds far too like a "boom." I must admit the number of knobs, at first, seems rather terrifying, but any prospective builder may take my word for it that they all play their part in achieving just the very best quality that conditions at the time of listening will permit, and surely that is what every quality enthusiast desires. The tone control, too, works beautifully, on both radio and gramophone, and on 50 cycle mains hum is imperceptible. Obviously some pains have been taken to specify only the very best components to perform their respective tasks. To close, *The Wireless World* appears to have achieved the ultimate in quality reception until such time as stereophonic transmission comes within the realm of practical politics. Just a word of warning to prospective builders in regard to the fuses in the anode leads of the rectifier. Normally these are 150 mA rating, and in the first three days after completing I blew four pairs of these despite the very greatest pains being taken to find the cause. I replaced these with 250 mA. type and have had no further trouble, nothing has got hot, and the total HT current is still normal, so it would appear that with 150 mA. type we are rather *too* near the safety line, as they did not fuse at once but after various intervals of working from 15 minutes to even an hour and a half.

Colwyn Bay, N. Wales. H. BRYAN DAVIES.

Lorenz Blind Landing System

IN your issue of April 5th I attributed the basic principle of the Lorenz Blind Landing System to Dr. P. Von Handel, of the Deutsche Versuchsanstalt für Luftfahrt. Dr. Von Handel has since written to say that while he himself developed the vertically polarised landing beam, the design of the beacon for purposes of horizontal navigation was carried out by Dr. E. Kramar, of the Lorenz Co. Both collaborated in the final work of combining these two principles to form a complete blind landing system.

R. P. G. DENMAN.

Hounslow, Middlesex.

Random Radiations

By "DIALLIST"

The Jubilee Broadcasts

THE B.B.C. deserves every kind of congratulation for the splendid way in which it helped the country and the Empire to celebrate Jubilee Day. No descriptive commentaries have ever been better done than those on the procession to St. Paul's Cathedral, and the relay of the service itself was a fine piece of work. Then in the evening the conception of broadcasting greetings to the King from all parts of the Empire, leading up to His Majesty's speech to his people, was brilliant, and the transmission, marked by no single hitch, was a fitting culmination to the months of hard work put in previously by the departments concerned.

The identity of the "Anonymous Commentator," who described the procession and the Ceremony of the Sword from a point near Temple Bar must remain a secret, though many wondered who he was, and were loud in their praises of the way in which he performed his task.

A Television Suprise

IT is announced that no television receiving sets will be shown on the manufacturers' stands at the Wireless Exhibition at Olympia next August. This, I feel, is rather a pity, but by way of compensation a non-commercial exhibit and demonstration of television is to be staged. There is no question that a great deal of harm was done for some weeks to the wireless industry at the beginning of this year by the ridiculous scares and rumours that were in the air, but sensible people have realised long ago that normal "sound" reception has nothing to fear from television as a competitor, for the very good reason that it isn't a rival at all.

Anything like a campaign to belittle television and its possibilities will simply defeat its own object. There is nothing so fatal in this world as protesting too much. It is much to be hoped that those who are responsible for organising the Exhibition will see their way to altering their decision about the exclusion of television apparatus.

Car Radio Approved

THE Minister of Transport has given his official approval to car radio. When it was first introduced into this country there were not a few who regarded it as likely to increase the dangers of the roads, fearing that it might distract the attention of drivers from the work in hand. I myself used wireless in a car years before built-in sets were heard of. It is my wont when opportunity offers itself to run down to the West Country for reasons not unconnected with fishing. It is a drive of something over 200 miles, apt to become rather a dull business when undertaken alone.

For that reason I contrived a long while ago a portable set which travelled on the back seat of the car, and was switched on whenever the need for diversion was felt. I found it an immense boon in its day, though it was, of course, nothing like so good as a modern car radio set with automatic volume control and all kinds of other improvements.

I must say that I've never found wireless reception at all a handicap to careful driving; certainly it is vastly less so than a talkative passenger. Some people, though, have queer ideas about what motorists should or should not do. In Sweden there is, or was, a regulation that one might not smoke whilst driving a car!

A Prize Suggestion

Speaking of car radio reminds me that some months ago I was asked in all seriousness by a friend, who is looked on as being a more than ordinarily intelligent person, whether car television sets would be possible! And he is a motorist, too. Whatever else may happen one can say very definitely that car television won't—unless, of course, it is installed purely for the passengers and completely out of the driver's sight. There would then be no chance of his driving up a televised street instead of the real one.

Two-Channel Reception

WHEN it is particularly important for a short-wave transmission to be received without fading, as is the case when relaying is being done, two different channels are often used nowadays at the same time. The twin transmissions do not fade together, hence one of them is always coming through with sufficient strength at any given instant. Rather elaborate apparatus is used for "mixing" the two signals and feeding only the stronger to common output stages.

Whilst the wireless man-in-the-street may not wish to undertake anything so ambitious as this, he can, if he possesses two receiving sets, sometimes make sure of good reception of a programme from medium-wave stations that might otherwise be ruined by fading. Any reader who has a bent for experiments will find it interesting to see what can be done with pairs of stations such as Munich and Nürnberg or Milan I and Turin. The two members of each of these pairs—and there are many others—transmit the same programmes; but since they use widely different wavelengths they do not fade simultaneously. The results obtainable in this way are most instructive and the possibilities that they open up are considerable.

Also Worth Trying

Another experiment that I can recommend as being well worth while is that of tuning the aerial circuit of a three-valve or four-valve straight set. In some instances the improvement in results is almost beyond belief. In the old days, when valves were very inefficient by comparison with those that we have to-day, we used to obtain good reception from many weak and distant stations with sets in which the aerial circuit was very loosely coupled to the grid circuit of the first valve, both being independently tuned—old hands will remember the A.T.I. and A.T.C., abbreviations which stood for aerial tuning inductance and aerial tuning condenser. One great drawback to this system is that it is impossible to gang the two tuned condensers owing to the comparatively large capacity of the aerial. For this and other reasons it was abandoned in favour of the present method, when valves of higher efficiency became common and the public demanded one-knob tuning.

Given a loosely coupled and independently tuned aerial circuit amazing things can be done. For it must never be forgotten that single-dial tuning severely limits the results obtainable from any combination of valves and circuits in a straight receiving set.

Live and Let Live

THOUGH there is no manner of doubt that the wireless receiving set is one of the greatest boons of to-day, there are times when one almost wishes that it had never been invented! Most readers will have known such feelings. They occur most poignantly when your neighbour on one side is letting the world in general know what a splendid set he possesses by reproducing an organ solo with the volume control full on and all windows open, what time your neighbour on the other side is doing much the same thing with a hot jazz number. However great his enthusiasm and his love of majestic volume, the wireless man should always remember his neighbours, if he has any. Don't imagine that you are giving them a treat by filling the air with music; very few wireless sets are pleasing to the ear when heard at a distance, and in cases where there are pronounced resonance effects a listener a hundred yards or so away may hear little but one or two constantly recurring and utterly maddening notes.

Blaring

One has heard this called an age of noise, and certainly our towns and villages are much less quiet places than they were years ago.

It is, perhaps, because the general noise level has risen so much that some people apparently find life dull unless they are listening to very loud music. The other day I went to a big sports meeting, and, ere the events began, gigantic loud-speakers almost deafened us with musical selections. There is only one kind of music that lends itself at all to this kind of thing, and that is the brass band. But we didn't have brass bands; we had, of all things, innumerable vocal solos. However free from distortion the reproduction may be technically, your basso and your tenor are not pleasing to the ear when they are made to bellow as no Bull of Bashan ever did.

That same evening I had to attend a meeting in a large hall, and there again we were treated to a positively overpowering volume of sound to while away the time before the proceedings started. Almost wherever you go nowadays on public occasions the blaring loud-speaker greets you. Do people, I wonder, really like this terrific noise, or do they just put up with it because they imagine that others are enjoying it?

WIRELESS CONSULTING ROOM

Medical Advice for the World

A MEDICAL consulting room literally at the disposal of the world is an idea which is to be put into practice by the Italian "Direzione Generale di Sanita." The proposal was recently put to Signor Mussolini, and the Duce immediately gave a warm assent, with the result that a unique medical institution will open in the near future.

The consulting room is to be situated in the studios of the Rome broadcasting station, although quite independent of the broadcasting organisation. There will be regular day and night medical attendants, the best doctors in Italy being available at all times. Urgent medical enquiries by wireless from all parts of the world will be speedily considered and the answers transmitted over the ether.

An interesting technical arrangement is provided for transmitting replies on any wavelength specially requested by the enquiring transmitter.

Signor Mussolini, in giving his support to the movement, said that in cases of sickness it was the duty of every human being, no matter what nationality, to give all the assistance that lay in his or her power. Therefore, the new consulting room would be available to all.

Signor Mussolini gives his warm support.

Frequently there are cases which can be dealt with successfully only by a specialist; sometimes only one or two men in the world may be qualified to cope with a particular disease.

Interesting apparatus developed by Professor Pende, of Genoa, will be used for registering heart beats and the action of the lungs of patients at great distances from the receiving station.

The permanent wavelength of the first wireless medical consulting room in the world will be fixed upon during the next few days. There will be twelve doctors on the staff at the beginning, but later on the Direzione Generale di Sanita hopes that the important medical authorities in all countries will send doctors and specialists to Rome to take a share in this new work for the benefit of all the world.

M. L.

Foundations of Wireless

Part XXII.—LF Amplification and the Output Triode

By A. L. M. SOWERBY, M.Sc.

THIS instalment deals with the conditions under which LF amplifying valves (transformer- and resistance-coupled) are normally operated, and also treats the question of the output valve from the aspects of permissible harmonic distortion and maximum power.

WE have now covered, in outline and principle at least, the subject of high-frequency amplification; and though the reading, or even the close study, of preceding instalments will not by any means develop the reader of them into an expert designer of receivers, it should at least enable him to follow with full comprehension those articles dealing with the latest developments of the subject that appear from time to time in these pages. That defines, approximately, the scope of a series dealing primarily with "foundations."

In the matter of detection, too, the foundations have been laid—with, perhaps, a little superstructure for good measure. The main subject that remains deals with the amplification of the low-frequency detected signals.

One of the standard methods of low-frequency amplification, *resistance coupling*, was used as the type of amplification in general in discussing the triode in Part XIII. An alternative method involves the substitution of a transformer for the resistance, with the dual aim of allowing a greater DC voltage to reach the anode of the LF amplifying valve (or detector) and of obtaining a little extra gain by virtue of the step-up ratio of the transformer.

In Fig. 117 there are shown skeleton diagrams of a transformer-coupled stage. Since we desire to amplify signals of all frequencies to the same extent, the voltage developed across the primary in circuit (*a*) must be independent of frequency. The primary constitutes an inductive load, the reactance of which rises with frequency; to attain even amplification it follows, therefore, that the voltage across it must be substantially equal to μVg at even the lowest frequency in which we are interested, since it will certainly rise to within a fraction of this figure at the highest. For this, the inductance of the primary must provide a reactance which, even at a low frequency, is high compared with the AC resistance of the valve. In the "equivalent anode circuit" of Fig. 118, the primary inductance Lp is in series with the AC resistance Ro of the valve, and receives

$$2\pi f Lp \sqrt{Ro^2 + (2\pi f Lp)^2}$$

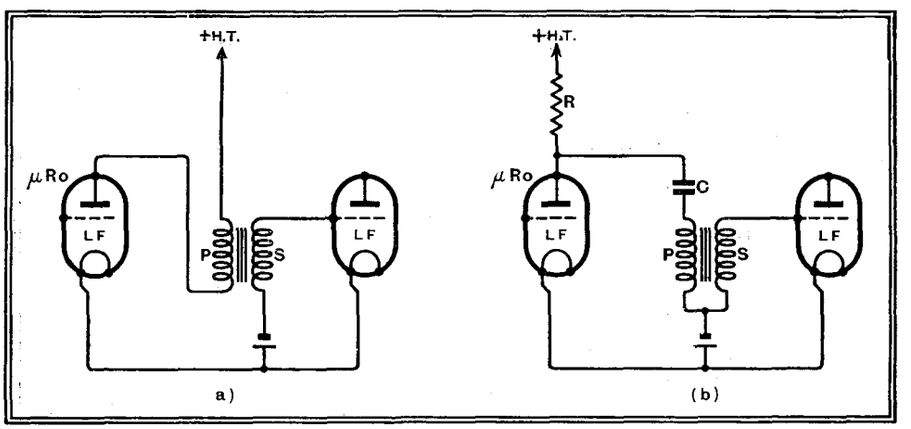


Fig. 117.—Transformer-coupled LF stages. In (*a*) the steady current of the first valve passes through the transformer primary P; in (*b*) it is carried by R.

of the generated voltage μVg. If the primary reactance $2\pi f Lp$ is equal to Ro, the amplification afforded will be 0.707μ, or 3 db. less than that at a high frequency at which $2\pi f Lp$ considerably exceeds Ro. If we accept this condition as representing a tolerable drop in gain at the low frequencies, we have at once a convenient design formula: $Ro = 2\pi f Lp$.

For a given valve and transformer, this tells us the lowest frequency that is satisfactorily amplified; for a 10,000-Ω valve and a transformer for which $Lp = 100$ H. the drop to 70 per cent. of maximum amplification will occur at $f = Ro/2\pi Lp = 15.9$ cycles. Evidently, with so good a transformer as this a valve of higher Ro, and hence higher μ, might be chosen. If we are content to set our limit at 50 cycles, then, with the same transformer, $Ro = 2\pi \times 50 \times 100 = 31{,}400$ ohms. This, therefore, is the highest permissible value of valve resistance. Or if Ro stays at 10,000 Ω, we can use a less bulky transformer, for which Lp is given by $Lp = Ro/2\pi f = 10{,}000/2\pi \times 50 = 31.8$ henrys.

It is important to note that the necessary value for the primary inductance is that which holds in actual use, with the steady anode current of the valve passing through the winding. This, by setting up a permanent magnetisation of the iron core, tends to prevent it responding to the signal current, which has to superpose on this the varying magnetisation from which the secondary derives its energising voltage. In other words, the inductance is decreased below its "open-circuit" value by the steady current.

The Resistance-fed Transformer

This effect can be allowed for by making sure that the minimum value of Lp prescribed by the formula is reached even with the steady current passing through the winding, or alternatively by diverting the steady current through another path, as in Fig. 117(*b*). Most modern transformers have cores of high-permeability material (Mu-metal, etc.) which attain magnetic saturation with quite a small primary current. For these the "parallel" circuit shown at (*b*) is essential. The feed-condenser, if large enough, has no effect whatever on the voltage across Lp at any frequency, but by cunning choice of a suitable value for C it may be made to maintain the bass response of a transformer at frequencies lower than that to which it would respond satisfactorily with a condenser of indefinitely large capacity. In effect, C and Lp form a tuned circuit, tuning flatly on account of R and Ro, which are virtually in parallel with it, by which the extreme bass can be maintained. Instructions for the choice of C, R, and Ro are generally given in the instruction-slip accompanying a transformer. Those who wish to go more deeply into this subject, which is of interest more to the designers of transformers

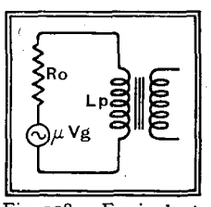


Fig. 118.—Equivalent anode circuit of a transformer-coupled stage.

Foundations of Wireless—

than to the users of them, are referred to an earlier article in this journal.[1]

The matter of high-note response from a transformer is a complex one, depending partly on the stray capacity across the transformer—which should evidently be kept at a minimum—and on a transformer characteristic (leakage inductance) not usually known to the ordinary user. Owing to this lack of available data on the point, no discussion of high-note response will be embarked on here.

The question of stray capacities arises again in connection with a resistance-coupled stage, in which high notes will be lost if the stray capacity is such that its reactance at the upper frequencies is not high compared with the AC resistance of the valve. High notes of frequency f are reduced to 70.7 per cent. of their correct voltage ("3 db. down") when $1/2\pi fC = R\,Ro/(R+Ro)$, where R, C, and Ro have the values indicated in Fig. 119. It will be clear that where a high capacity is inevitable (as in long screened leads, for example, or feeder lines to a distant amplifier) the choice of a valve of low AC resistance, with an external coupling resistance of low value, will ensure that loss of the

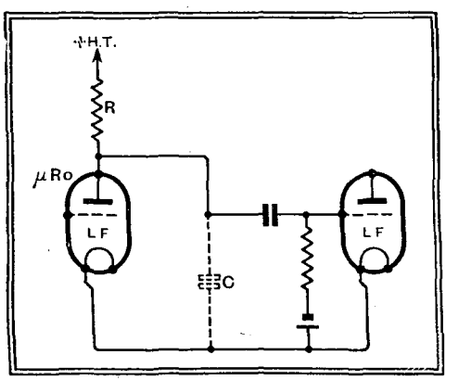


Fig. 119.—Showing stray capacities C in a resistance-coupled LF stage. High notes of frequency f receive 70.7% of the amplification of low notes when $1/2\pi fC = RRo/R + Ro$.

higher frequencies is kept within reasonable bounds. If the frequency for which the equation given above is satisfied lies at 10,000 cycles or over, all will be well—and there will be a margin in hand to cover any underestimate of either capacity or resistance.

The question of loss of low notes in a resistance amplifier is purely a matter of grid-condenser and grid-leak values; it was dealt with at the end of Part VI of this series.

The Output Valve

When amplified sufficiently, the signal is passed from the last valve in the set to the loud speaker, there to move a diaphragm which re-creates, with more or less fidelity, the sound-waves from which the original modulation was derived. To agitate the diaphragm of a loud speaker *power* is required; the output valve has therefore to be so chosen, and so worked, that the greatest possible amount of power is delivered to the loud speaker. To provide large power, high anode current and high anode voltage are required; an output triode is therefore a valve of low AC resistance and may be rated to operate at voltages up to 400.

[1] Aughtie and Cope, *The Wireless World*, Dec. 11th, 1929 p. 644.

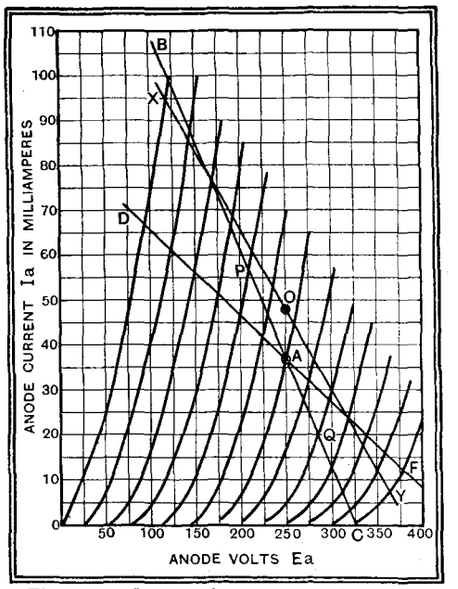


Fig. 120.—Curves of an output triode rated for 250 V max. Ea. The load-lines shown are discussed in the text.

The properties of an output valve are deduced, in much the manner already discussed in Part XIII, from load-lines drawn across the $Ea - Ia$ curves. A set of such curves for an output triode are reproduced in Fig. 120. In discussing a resistance-coupled stage the load-line (Fig. 71) cuts the line $Ia = O$ at the voltage of the anode battery, thereby indicating that the voltage at the anode of the valve could only rise to this value at zero anode current. In the case of an output valve the load consists of the windings of the speaker itself or of an output transformer, either of which has a comparatively low resistance. If, for the sake of simplicity, we regard this resistance as negligibly low, the voltage at the anode of the valve will be that of the anode battery itself, and the curves of the valve-plus-loud speaker combination, if measured with direct current, will be those of Fig. 120. Let us suppose, then, that we decided to work the valve at $Ea = 250$ V., and that we set the bias at -30 V. This gives the working point A, for which $Ia = 37$ mA.

Even though the speaker offers no resistance to DC, it will have quite a large impedance to signal currents; if we consider this impedance as purely resistive and as having the same value for all the frequencies in which we are interested, we can represent it by a load-line passing through A. Since the AC resistance of the particular valve illustrated is about 1,000 Ω, we will make a load-line for 2,000 Ω, on the grounds that the best load is usually about equal to 2 Ro. This line is shown at BAC.

If we apply a signal of 10 volts peak the anode current will now swing between P and Q, or from 57 to 20 milliamps. The rise for the positive half-cycle is thus 20 mA., the fall for the negative half-cycle only 17 mA. This difference, clearly enough, will introduce distortion. Unless the grid-swing is restricted to fantastically small dimensions, the distortion will not *entirely* vanish. We therefore have to set a more or less arbitrary limit to the amount of distortion we propose to permit; that generally accepted allows distortion equivalent to the introduction of 5 per cent. of second harmonic. This is reached when the lengths AQ and AP stand in the ratio 9 to 11.

Choosing the Load

In the present case the grid-swing may be extended to about 15 volts each way, giving a change in Ia of $+30$ and -25 mA. before this limit of distortion is reached. Corresponding to this total current-swing of 55 mA., there is a voltage-swing of 110 volts. The corresponding peak-values of signal current and signal voltage in the load are 55/2 and 110/2, and the RMS values 55/2/2 and 110/2/2. The AC power delivered to the speaker is the product of these, or $(55 \times 110)/8 = 756$ milliwatts.

The restriction of the grid-swing made necessary by the early attainment of the 5 per cent. distortion limit indicates that the load has been wrongly chosen. Going through the same process of drawing load-line, investigating permissible grid-swing before the distortion-limit is reached, and calculating from the current and voltage swings the power delivered to the speaker enables us to find the power than can be delivered into each load. The values of these are given as a curve in Fig. 121.

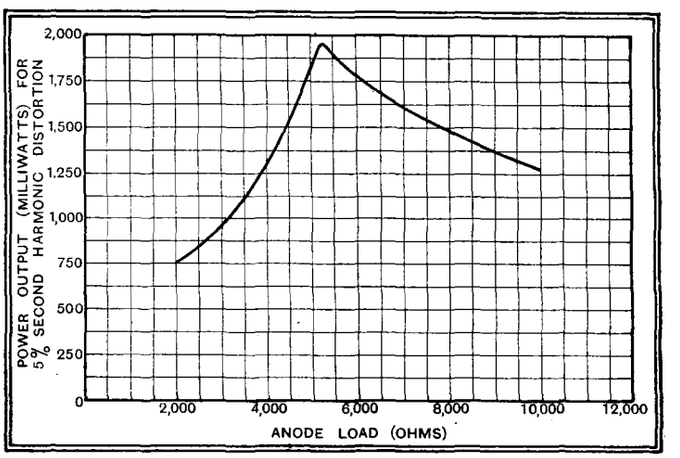


Fig. 121.—Relation between anode load and available power, allowing 5% second harmonic distortion, for the valve of Fig. 120 worked at point A.

Foundations of Wireless—

The *optimum load*, being that into which the greatest power can be delivered, is evidently about 5,200 Ω—the corresponding load-line is drawn at DAF on Fig. 120. To achieve this power the grid requires a signal that swings it from 0 to −60 V., giving a swing in anode current from $12\frac{1}{2}$ to 67 mA. The two excursions from A are exactly in the ratio 9 to 11, showing that distortion equivalent to the introduction of 5 per cent. second harmonic has just been reached. The power available for the loud speaker is now

$$\frac{(67-12\frac{1}{2})\times(378-94)}{8}=\frac{54\frac{1}{2}\times 284}{8}=$$

1935 mW.

It will be remembered that the choice of A as the working-point was purely arbitrary—it is quite possible that some other point would give greater power. Still keeping to $Ea=250$ V., which, being the highest voltage for which the valve is rated, will quite certainly give the greatest output,[2] other points can be investigated in the same manner as A, and then, by comparing the outputs given by the best load for each point, we can finally pick the best possible working-point and load. For the valve of Fig. 120, this is given by $Ea=250$, $Ia=48$, $R=2930$ Ω. For this, the available power is 2,670 mW., as can be deduced from the final load line XOY.

In general, the user of a valve is not compelled to go through this elaborate examination of valve-curves, for the makers' recommendations as to anode voltage and current, grid bias and optimum load are set forth in the instruction-slip accompanying each valve. The user has only to do as he is told.

In the matter of providing the optimum load he is rather at sea; he can do no more than ask the maker of his chosen loud speaker to supply it with a transformer suited to the valve he proposes to use. The ratio of the transformer, as reference to Part X will show, should be $\sqrt{\frac{R}{Rs}}$, where R and Rs are respectively the required load and the mean impedance of the speech-coil.

The load offered by a loud speaker is usually partly resistive and partly inductive. A recent article in these pages (Valve Diagrams for Loud Speaker Loads; March 29, p. 324, and April 5, p. 344) has dealt comprehensively with this aspect of the question, and to it the reader is referred for a continuation of this subject.

[2] The power output given by a valve is related to the anode voltage applied thus: Power $\propto (E_a)^{3.2}$

Cossor Cathode-Ray Tubes

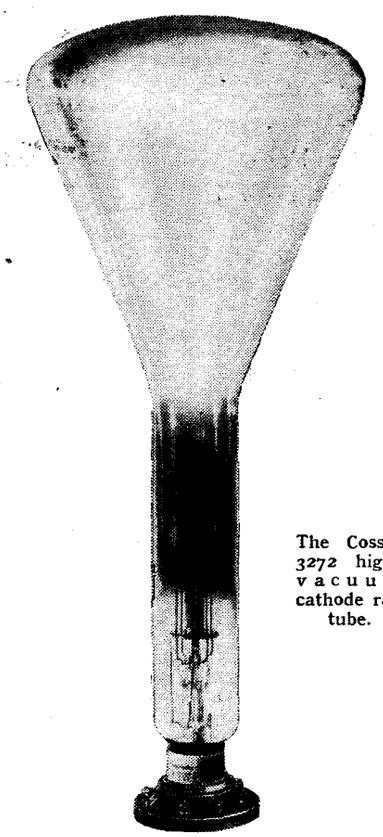
High Vacuum Tubes for Television

IT is now generally realised that for the reproduction of high-definition television the high vacuum type of cathode-ray tube is essential, and Cossor now list a number of tubes designed expressly for this purpose. The largest bears the number 3272, and has a diameter of no less than $12\frac{1}{2}$in. with a length of 26in., so that the picture may be as large as 10in. by 8in. The tube is priced at 15 guineas, and is fitted with a 10-pin base, its filament consuming 1.25 amperes at 0.4 volt. It is rated for a maximum third-anode potential of 4,000 volts. The second anode should have applied to it one-quarter of the third-anode voltage, while the potential of the first anode can lie between zero and that of the second anode, the shield voltage being equal to the first anode voltage.

The electric sensitivity is given as 750/V mm. per volt where V is the third-anode voltage. Where this is 4,000 volts, a deflection of $750/4{,}000=0.1875$ mm. $=0.074$in. is obtained for every volt applied to the deflecting plates. It can be seen, therefore, that for a picture of 10in. by 8in. the peak voltage applied to the horizontal deflecting plates from the time base must be $10/0.074=135$ volts, and to the vertical plates $8/0.074=108$ volts.

Smaller Diameter Tubes

Smaller tubes than this are listed, such as the 3274 with a diameter of 10in. and a sensitivity of 500/V mm. per volt, and the 3271 with a diameter of $6\frac{3}{8}$in. and a sensitivity of 320/V mm. per volt. Both these tubes are rated for a maximum third-anode potential of 3,000 volts, and the potentials applied to the other electrodes follow the same relations as in the case of the 3272.



The Cossor 3272 high-vacuum cathode ray tube.

All three models are available with the type H screen, which gives a sepia tone picture of the type normally obtained in cathode-ray television reproduction. They can be supplied with a type J screen, however, which gives a light blue response forming a picture which approximates to black and white.

Some Useful Notes

The leaflet describing these tubes gives some useful information on their operation, and for high-definition television a hard-valve time base is recommended for the horizontal or line scanning only, while a gas-filled triode time base is advised for the vertical or picture scanning. The latter is, of course, unsuitable for very high speeds, but gives a much more rapid return stroke than the circuit employing hard valves. It cannot, therefore, be used very satisfactorily for the line scanning at the present time where many lines are used. Although the hard-valve circuit works well at high speeds, the length of its return stroke renders it less suitable for the picture frequency, and the gas-filled triode is ideal for this purpose. A push-pull output circuit from the time base is recommended for two reasons: first, to maintain accurate focus over the whole picture, and, secondly, to avoid trapezium distortion by holding each pair of plates at the same *mean* potential relative to the third anode.

Some useful notes on the mains equipment are also given. Although the third anode should be at earth potential, it is stated that it is inadvisable to earth this electrode, as it may introduce mains hum. It is advised, therefore, that the third anode be earthed through a high resistance and the cathode earthed through a condenser which must be rated to withstand a high voltage.

THE RADIO INDUSTRY

AN arrangement has been made between Philips Radio and Chrysler Motors, Ltd., whereby a special type of aerial is to be erected in the roof of Chrysler cars. This aerial has been designed especially for use in conjunction with Philips "Motoradio," and no suppressors are necessary on the sparking plugs when the set is fitted.

Microphones of all kinds, from the simple button pattern costing a shilling or so to high-quality Reisz and condenser types, are described in a catalogue issued by Electradix Radios, 218, Upper Thames Street, London, E.C.4.

A new range of Ever Ready super-capacity HT batteries has just been introduced. Various voltages are available; as an example of price, the 120-volt battery costs 10s. 6d.

A particularly ambitious public address installation was set up in connection with the Jubilee celebrations by the Trix Electrical Co., Ltd. Seventy loud speakers in a number of buildings in the neighbourhood of Pall Mall, Cockspur Street and Trafalgar Square were used; these were fed from a central station with a commentary on the ceremonies.

Ward and Goldstone, Ltd., of Pendleton, Manchester, are well known as manufacturers of low-capacity low-loss screened aerial leads for use without matching transformers; it is not so widely known that they also produce "Statoformers" for connection to screened transmission lines of the ordinary type. Useful technical information on the application of these devices is given in a leaflet issued by the makers.

The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	507
The Permeability Battery Four	508
Single-span Tuning and the Quartz Crystal	511
American Television Tests	513
Electrical Organ Tones	514
Unbiased	516
Current Topics	517
Wireless and the Atmosphere—III	518
Lotus Model 66 Reviewed	520
Listeners' Guide for the Week	522
New Apparatus Reviewed	524
National Television Plans for Germany	525
Hints and Tips	527
Broadcast Brevities	528
H.F. Chokes : Construction and Performance	529

EDITORIAL COMMENT

The Future of Broadcast Wavelengths

Local Distribution

ALTHOUGH we seem to have settled down as the result of some years of experience to the idea that medium wavelengths are ideal for general broadcasting purposes, it is interesting to speculate as to whether this view will hold in the years to come.

Quite obviously, any drastic or hasty change could not be contemplated, for the scrapping of medium-waveband transmitting stations, even if the advantages of so doing were immense, would render sets in universal use obsolete as well as the transmitting stations themselves, and such capital loss could not be entertained.

But, nevertheless, the coming of television on ultra-short wavelengths does open up the possibility that sound broadcasting on these wavelengths may gradually achieve popularity amongst listeners to a point where regular listening as at present, on the medium wavelengths, may go out of fashion. A factor which would contribute to such a state of affairs would be the very much better quality which it is likely will be attained with the ultra-short wavelengths on a wide frequency band, as compared with the present medium waves where only a restricted band is available, and even then reception is subject to interference not experienced on ultra-short waves, for it must be remembered that the range of the ultra-short waves is limited and, in consequence, interference from stations far afield is minimised.

We can imagine that some countries would be very disinclined to change over to ultra-short-wave broadcasting, if only for the reason that their transmissions would no longer travel to distances beyond their frontiers, and hence their value for propaganda purposes would disappear. If, however, for example, a complete network of ultra-short-wave stations throughout this country is established, so that all districts are within the service range of one or more of these stations, it may be hard to justify the continuance of the medium broadcast band transmissions. It could well be argued then that the B.B.C. was monopolising an unnecessary number of wavelengths, just as the same objection would be raised if several long-wave channels were in use for broadcasting in addition to those in the medium band.

Television Demonstrations

A Lesson from Germany

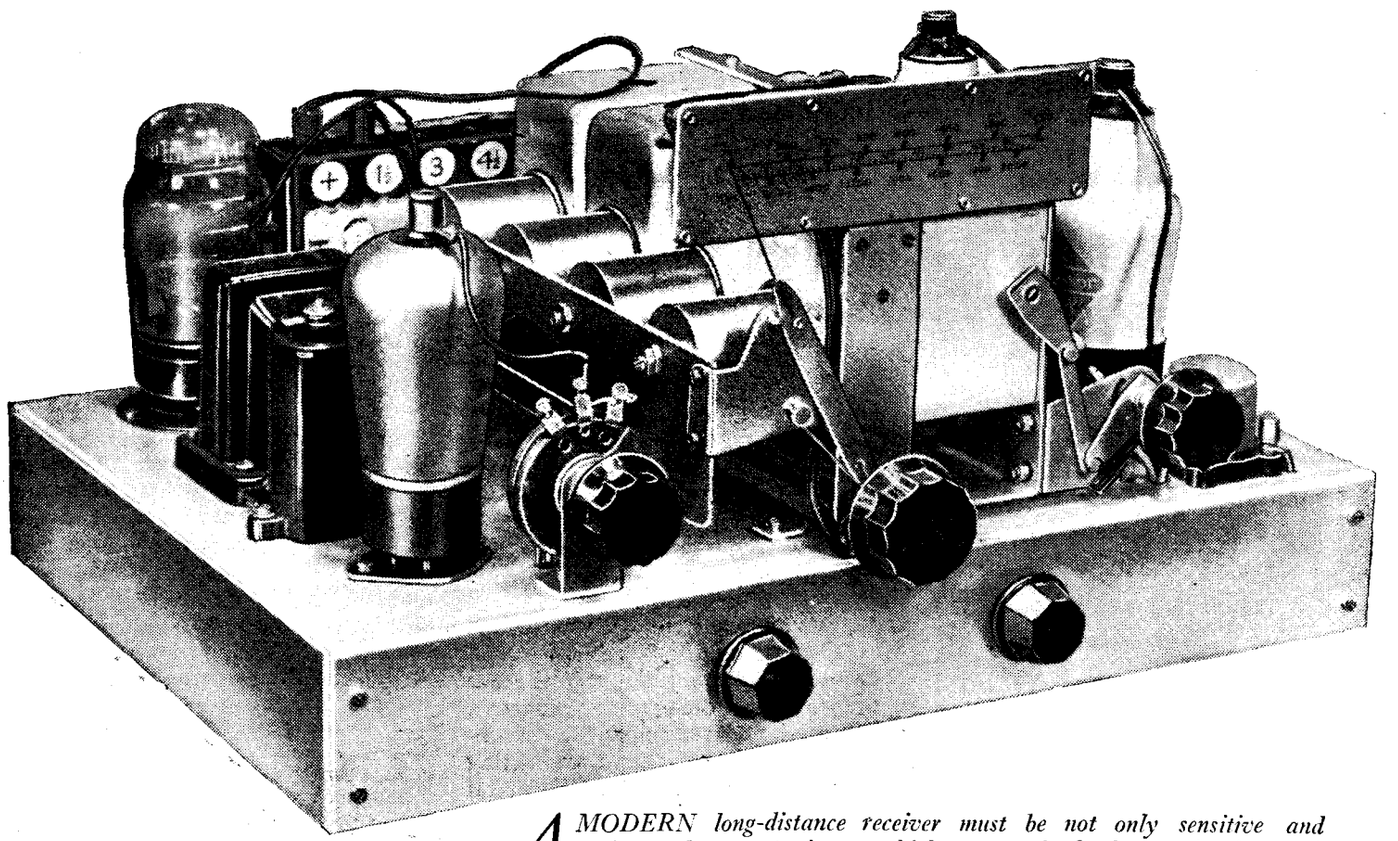
WE have frequently recommended that, in order to bring home to the public the improvements in quality of reproduction in broadcast receivers that are being achieved as design progresses, facilities should be given for the public to listen at convenient centres under ideal reception conditions with good quality apparatus of standard type.

When the television high-definition service begins the need for facilities for public demonstration will be still greater, for the public has at present no idea what television can offer, and only a very small proportion of the public have ever witnessed television in any form.

In Berlin the Post Office has already arranged facilities for the public to attend demonstrations under normal conditions with standard television receivers since the inauguration of a television service there. The prospective purchaser of a set can, therefore, find out for himself what possibilities in the way of entertainment await him.

The Permeability Battery Four

A Sensitive and Economical AVC Set



A MODERN long-distance receiver must be not only sensitive and selective but must give as high a standard of reproduction as is compatible with the degree of selectivity achieved. This calls for constant selectivity, which can only be obtained in a straight set through the use of permeability tuning. This system is employed in the set described in this article in conjunction with two stages of HF amplification to which AVC is applied in order to reduce fading as much as possible and so obtain a maximum of performance in long-range reception.

THE design of a receiver in which permeability tuning is used instead of the more conventional variable condensers is a matter of considerable interest, for there are many factors, good or bad, which are taken for granted in the ordinary system, but which become profoundly modified with the new method. When a coil of fixed inductance is tuned by variable condensers the performance obtained inevitably varies over the tuning range. With a coil of normal design the selectivity increases as the resonance frequency is lowered by increasing the capacity of the variable condenser; the dynamic resistance, however, upon which amplification depends, falls. In the ordinary straight set, therefore, the sensitivity usually falls off as the wavelength increases and the selectivity becomes much greater than at low wavelengths.

Now, with permeability tuning, it is the inductance which is variable, and in a correctly designed component the dynamic resistance and the selectivity are constant irrespective of the setting of the tuning dial. It would thus seem that this system offers a perfect solution to the problem of obtaining constant selectivity and sensitivity, but this is unfortunately not the case in practice, although there is no doubt that it offers a big improvement over condenser tuning. Used as an intervalve coupling a perfect permeability tuner will give quite constant amplification and selectivity provided that it be connected in such a way that the effective shunt resistance imposed on the circuit by other components is a constant. This shunt resistance comprises the internal AC resistance of the valve, the losses in the valve-holder, and similar effects.

At first sight it appears that these effects would not vary much with wavelength, and this would indeed be the case if it were not for the results of stray couplings between different parts of the amplifier. The stray couplings are chiefly capacitive in nature, and usually cause regeneration, the amount of which increases with an increase in frequency, and its effect is to make both the amplification and the selectivity higher by an amount which varies with wavelength. We may thus expect to find that a practical amplifier embodying permeability tuning gives neither constant selectivity nor sensitivity, but that both attributes increase as the wavelength is lowered—a result rather different from that found with condenser tuning. Provided that the stray couplings are kept within reasonable limits, and this is, of course, necessary to preserve stability when a high gain is attempted, the variations need be in no way serious, and do not compare with those found with conventional tuning systems.

When we come to consider the aerial circuit, and, above all, a pair of tuned circuits coupled in the form of a band-pass filter, however, we find that the character-

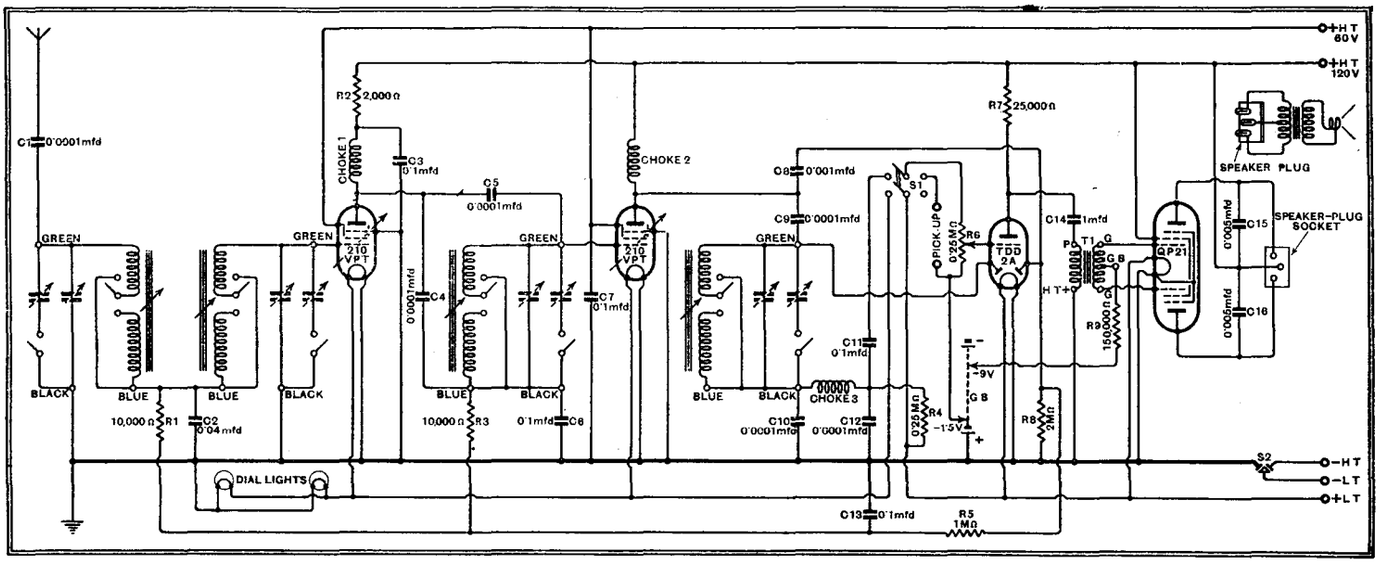


Fig. 1.—The complete circuit diagram shows that four tuned circuits are employed—two of them preceding the first valve. A duo-diode-triode provides detection, AVC, and LF amplification, while the output stage is of the QPP type.

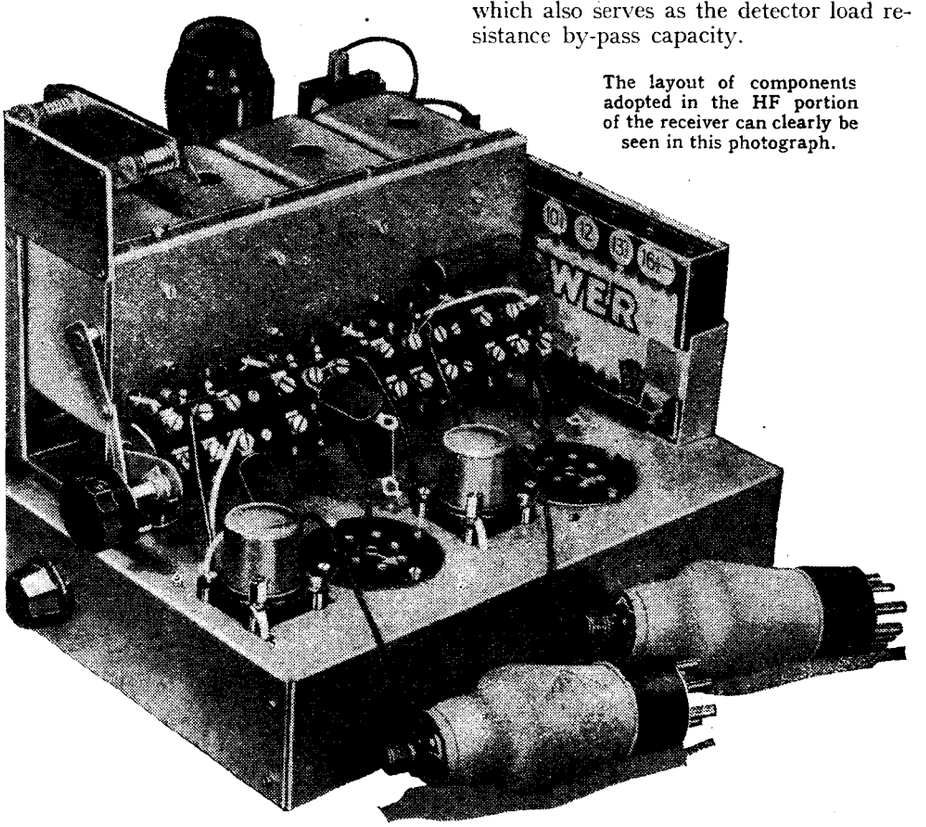
istics of a permeability tuner are not so well suited to the maintenance of the desired constancy of performance. Actually, in order to maintain constant selectivity and sensitivity it is necessary to employ a coupling which varies with wavelength in a special manner, and this is rather too complicated to be feasible in a practical receiver, at any rate at the present time. If a fixed coupling be used common capacity seems the best.

In view of these effects we must expect neither the sensitivity nor the selectivity to be quite constant, and experience indicates that the sensitivity varies over the waveband in roughly the same way as when condenser tuning is used, the variation being partly due to stray regeneration, but more to the band-pass filter. The selectivity, however, although not constant, varies much less than usual, and this is ample justification for the use of permeability tuning, as can be seen when it is remembered that an increase in selectivity means an increase in sideband cutting, and hence poorer quality of reproduction, for tone-correction can hardly be used to compensate for a variable high-note response.

The HF Stages

In order to obtain a considerable degree of sensitivity, two HF stages are employed in the Permeability Battery Four, and they are preceded by a pair of loosely coupled tuned circuits. The complete circuit diagram is shown in Fig. 1, and it will be seen that the aerial is connected to the high potential end of the first circuit through the 0.0001 mfd. condenser C1. The first valve is connected directly to the second circuit and the two coils are coupled by the common condenser C2 of 0.04 mfd., the AVC bias being applied through the 10,000 ohms decoupling resistance R1.

A tuned circuit of identical characteristics is connected to the grid circuit of the second HF valve, and here again the AVC bias is applied through a 10,000 ohms resistance, decoupling being obtained with the aid of this resistance R3 and the 0.1 mfd. condenser C6. The tuned circuit is shunted by a pair of series-connected 0.0001 mfd. condensers, C4 and C5, to the centre-point of which the anode of the first valve is connected. This leads to the equivalent of a 1-2 step-up transformer and is necessary in order to limit the effect of stray regeneration. The DC path to the anode for the H.T. supply is provided by the HF choke Ch1.



The layout of components adopted in the HF portion of the receiver can clearly be seen in this photograph.

The second stage of amplification is similar and the HT is applied through the choke Ch2, the tuned circuit being fed through the 0.0001 mfd. condenser C9. In this case neither side of the tuned circuit is earthed, since this leads to a much smaller HF potential being developed across the diode load resistance, and hence imposes much less stringent requirements upon the HF filter after the detector. The earth return path of the tuned circuit to high-frequency currents is thus completed through the 0.0001 mfd. condenser C10, which also serves as the detector load resistance by-pass capacity.

A duo-diode-triode is used for the detector, and the signal diode, which is mounted round the negative leg of the filament, is connected directly to the high-potential end of the tuned circuit, while the 0.25 megohm load resistance R4 is returned to positive LT in order to obtain

The Permeability Battery Four—

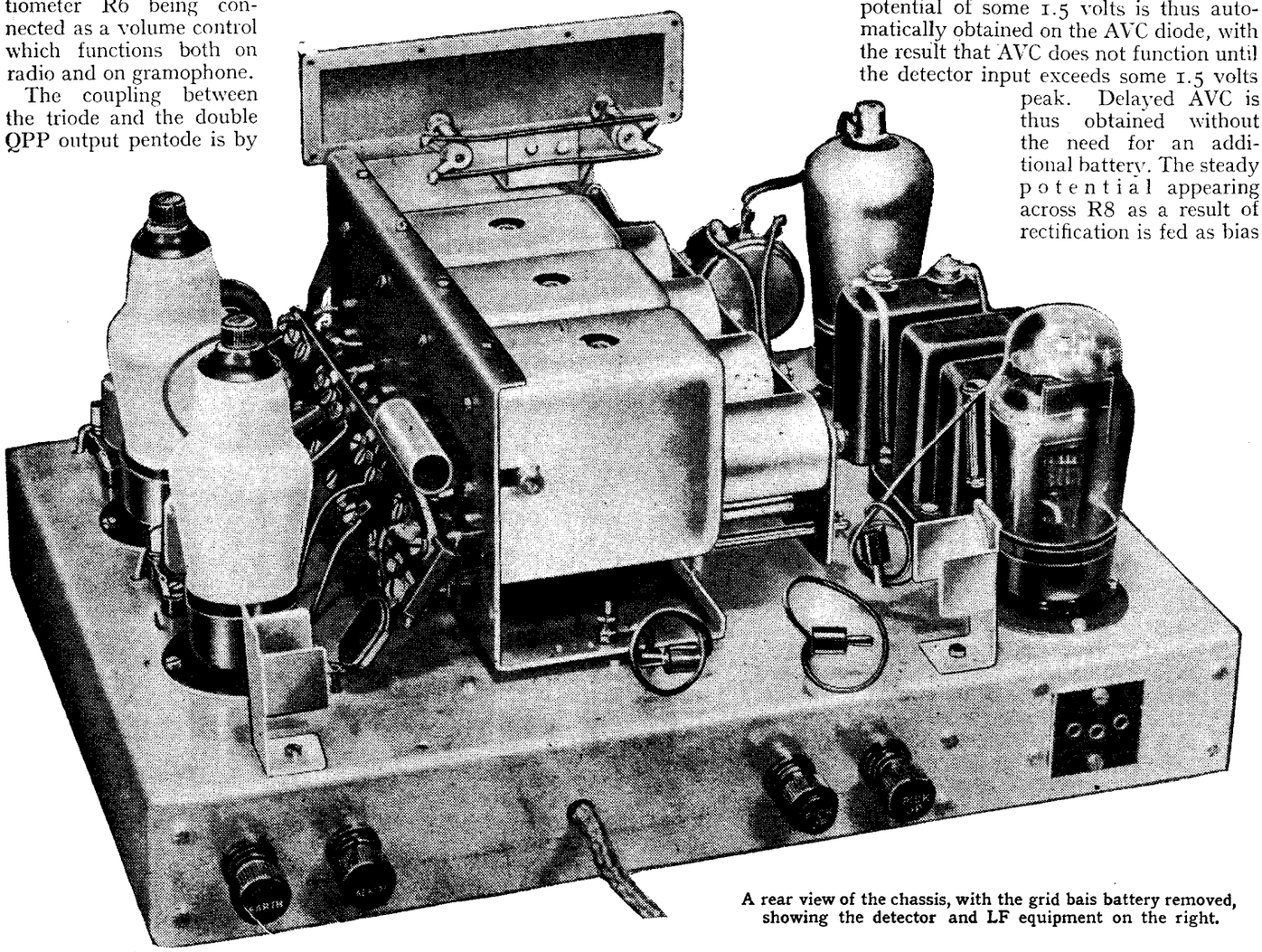
good rectification. The LF potentials appearing across the load resistance are fed to the triode section of the valve, which acts as a low-frequency amplifier, through the 0.1 mfd. condenser C11—the potentiometer R6 being connected as a volume control which functions both on radio and on gramophone.

The coupling between the triode and the double QPP output pentode is by means of a 1-8 push-pull transformer, the primary of which is resistance-capacity fed by means of the 25,000 ohms resistance R7 and the 1 mfd. condenser C14. In order to prevent the generation of parasitic oscillation in the output valve a 150,000 ohms resistance R9 is interposed between the centre-tap on the transformer secondary and the grid bias battery. In the anode circuit of this valve a QPP type output transformer is employed for feeding the loud speaker, and following the usual practice this is not a part of the set but is mounted on the loud speaker, and is, in fact, supplied with it. Two condensers, C15 and C16, each of 0.005 mfd. capacity, are connected across the halves of the output transformer primary, and serve several purposes. First, they tend to prevent parasitic oscillation; secondly, they prevent the load impedance from rising excessively at high frequencies; and thirdly, they prevent an excessive high-frequency response from being obtained.

Turning now to the AVC system, it will be seen that the second diode of the duo-diode-triode is used and is fed from the anode of the second HF valve through the 0.001 mfd. condenser C8. It is important that this precise point of connection be adhered to, for if the condenser were joined to the other side of C9, there would be a serious risk of distortion, although the AVC would function just as well. The distortion is brought about by the fact that with *delayed* AVC distorted LF potentials necessarily appear across the AVC diode load resistance, and the higher frequency components are fed back to the preceding circuit through the feed condenser C8. If this be connected to the detector diode they appear across the diode load resistance R4 and are applied to the LF amplifier, and may cause serious harmonic distortion to appear at high frequencies. If the feed condenser be connected directly to the anode of the HF valve, as in this receiver, however, the distorted LF potentials fed back through C8 cause no harm, for the anode to cathode path of this valve is of such a low impedance to low frequencies that it is practically a short-circuit.

An HF stopper comprising Ch1 and C12 is included between the signal diode circuit and the LF output, and in view of the fact that the diode load appears between the last tuned circuit and the earth line it has less work to do than is usual for a straight set. The LF circuits, therefore, are exceptionally free from stray HF currents.

The diode used for AVC is mounted round the positive limb of the filament, and the load resistance R8 of 2 megohms is returned to negative LT. A negative potential of some 1.5 volts is thus automatically obtained on the AVC diode, with the result that AVC does not function until the detector input exceeds some 1.5 volts peak. Delayed AVC is thus obtained without the need for an additional battery. The steady potential appearing across R8 as a result of rectification is fed as bias to the two HF stages through the filter comprising the 1 megohm resistance R5 and the 0.1 mfd. condenser C13, which effectively prevents both HF and LF feedback.



A rear view of the chassis, with the grid bais battery removed, showing the detector and LF equipment on the right.

A switch S1 is provided to change over from radio to gramophone, and, as already stated, the volume control functions on both. Two contacts of the switch are connected to break the LT circuit to the HF valves on gramophone, and this not only prevents a break-through of radio signals, but also reduces the current drawn from both the HT and the LT batteries. The two dial lights are also switched off on gramophone, where they are quite unnecessary. The receiver as a whole is controlled by S2, which not only breaks the LT circuit but also disconnects the HT battery at one end, so preventing it from being subjected to a continuous discharge should a by-pass condenser develop an internal leak.

(*To be concluded.*)

A list of the parts required to build this receiver has been printed on page 530.

Single-Span Tuning and the Quartz Crystal

The Application of Stenode Principles

By W. T. COCKING

IT is well known that the quartz crystal can be employed in such a way that it confers extremely high selectivity on a receiver, and the application of such a circuit to the single-span receiver is discussed in some detail in this article. It is shown that the type of selectivity curve obtained is the same as that given by reaction, namely, a very sharp resonance curve.

IN the year which has elapsed since its first introduction by *The Wireless World* the system of tuning known as single-span has proved itself to be eminently practicable and to have many advantages over other methods. The chief of these are the abolition of ganging, the avoidance of waveband switching, and the ability to cover a wide range of wavelengths with a single small tuning condenser brought about by the use of a high intermediate frequency, higher, in fact, than that of any signal to be received. The use of this high frequency, usually it is 1,600 kc/s, brings one disadvantage in its train, although this has not so far proved serious. This disadvantage is that the selectivity given by each tuned circuit is not as great as that obtainable from a circuit of similar efficiency operating at the low frequency employed in the conventional superheterodyne.

In consequence of this, more tuned circuits, or more efficient circuits, must be used in order to obtain equivalent selectivity, and in practice use has been made of the properties of reaction in increasing the selectivity of a receiver. With the aid of reaction it has proved possible to obtain a degree of selectivity with a reasonable number of circuits which is adequate for most requirements, although it is admittedly not as great as that obtainable with a low intermediate frequency. Now, if we attempt to increase the selectivity beyond the point which we have already reached while still using a frequency of 1,600 kc/s, we can only do it by increasing the efficiency of the tuned circuits or their number, or both. The efficiency of the conventional tuned circuit comprising a coil and condenser cannot be greatly increased without it becoming too costly and bulky, and the addition of extra circuits does not confer a great benefit as regards the reduction of adjacent channel interference, although it may greatly reduce interference from stations, such as a local, spaced several channels from the wanted signal.

We are, therefore, left with two alternatives in the search for better selectivity in an amplifier operating at a frequency in the neighbourhood of 1,600 kc/s—we can increase the efficiency of our tuned circuits by developing better methods of applying reaction, and we can attempt to find some form of tuned circuit which inherently possesses a sufficiently high degree of selectivity. We are thus naturally led to the quartz crystal, for although this is not a tuned circuit in the accepted sense of the words, it possesses the properties of such, and it is well known that when operating as a resonator it has an extremely high value of effective Q, that is, a high ratio of effective reactance to resistance.

The Quartz Crystal

The quartz crystal is in effect a series-tuned circuit shunted by a capacity which is the capacity between the two electrodes contacting with the crystal. In its applications for our purpose this capacity serves no useful purpose, and it is necessary to overcome its effects by a special circuit connection. A good specimen of quartz, however, properly connected in circuit, exhibits all the properties of an ordinary tuned circuit but possesses a resonance curve which is very much more

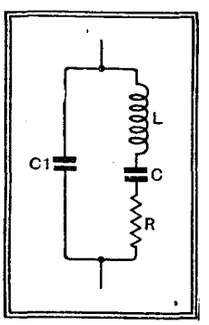


Fig. 1.—The equivalent circuit of a quartz crystal is that of a series resonant circuit L, C, R, with a shunt capacity C1 due to the holder.

selective. The use of quartz crystals in this way was first suggested by Dr. James Robinson, and they were employed by him in certain models of the Stenode, and it is their application to the single-span receiver which has recently been investigated by *The Wireless World*.

Early experiments showed that a great deal depends upon the type of crystal employed, and it was soon found that the majority of crystals exhibit more than one resonance frequency. This renders them quite useless for present purposes, for the receiver would obviously respond simultaneously to several different stations, and the extremely sharp resonance curve would then confer little advantage. A careful choice of crystal is, therefore, an essential to the attainment of satisfactory results.

A crystal having a single resonance frequency only can be accurately represented by the circuit of Fig. 1, in which L, C and R represent the effective inductance,

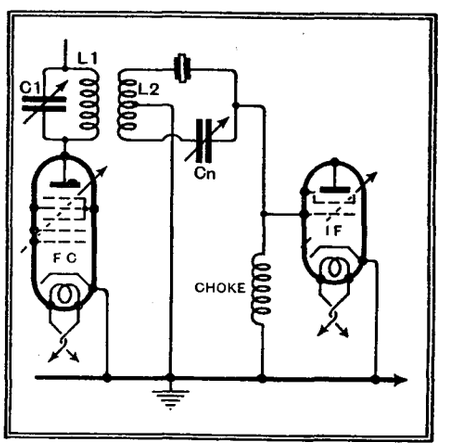


Fig. 2.—A practical circuit diagram showing the connections of a quartz crystal is given here. The crystal holder capacity is balanced by Cn, and, as explained in the text, the windings of the input transformer, L1 L2, should be screened from one another.

capacity and resistance, and C1 is the stray capacity of the crystal holder. The effect of this capacity can be overcome by employing a bridge circuit, and a typical arrangement is shown in Fig. 2. The coil L2 is coupled to the tuned IF circuit L1 C1, and its two parts, together with the crystal capacity and the balancing condenser Cn, form a Wheatstone bridge. If L2 be centre-tapped then the capacity of Cn must be the same as that of the crystal, and this is very small indeed. It is usually more convenient to tap L2 at about one-quarter the way from the end which is joined to the balancing condenser, for then the capacity required is greater, and may be as large as 10 $\mu\mu$F.

At resonance the crystal throws a heavy load on the tuned circuit if a 1-1 ratio be employed in the transformer which feeds it, for the series resistance of a typical crystal at resonance is only about 10,000 ohms. The greatest efficiency, therefore, is secured when a step-down ratio is em-

Single-Span Tuning and the Quartz Crystal—

ployed. The ratio to be used naturally depends upon the type of coil used and upon the degree of coupling, but it should be of the order of 2-1.

The impedance into which the crystal feeds is of considerable importance, and for the maximum selectivity it must not be a resistance which rules out the use of a tuned circuit, since this behaves as a resistance at resonance. A reactive load must be used and this will normally be the input capacity of the following valve, so that the grid-cathode circuit can be completed through an HF choke, Ch of Fig. 2, or a resistance of high value. The use of a resistance at this point is not ruled out, because the valve capacity is in shunt with it. Paradoxically enough, where a resistive load must not be used, it is permissible to employ a resistance but not a tuned circuit. The reason is, of course, that the resistance is shunted by the valve capacity and does not behave as such, whereas a tuned circuit at resonance exhibits the properties of a resistance.

In the practical application of the quartz crystal to a receiver, great care must be taken in the choice of the associated components and of their layout. It is essential that stray couplings between the pre- and post-crystal circuits be reduced to a minimum, otherwise there will be an audible leakage of signals by this path and the full benefit of the selectivity of the crystal will not be realised. It is also important that the capacity between the windings L1 and L2 of the input transformer (Fig. 2) be negligible, otherwise it will prove impossible correctly to balance the bridge circuit. Instead of a balance to zero being obtained, the balance will only be indicated by a minimum of signals which is sufficiently great to remove all the advantages of the crystal. This effect can readily be overcome, however, by screening the windings of the transformer so that energy can be transferred from the primary to the secondary only electro-magnetically.

Initial Adjustments

When points such as these have been attended to it is easy to secure the full selectivity, but care is needed in the initial adjustments, particularly of the balancing condenser. In general, the best procedure is to set the condenser Cn at minimum and to line up the IF circuits as nearly as possible to the crystal frequency, which is some 1,600 kc/s. Then mistune the receiver from the local, but not so much that its programme is not distinctly audible. The condenser Cn can now be adjusted and a critical setting should be found at which the signal disappears. The next step is to tune in a rather weak station at the exact point of the crystal response. The station may be audible on either side of this point, but the exact setting is easily recognised because the quality of reproduction completely changes and becomes very deep; moreover, if the tuning dial be rotated across it, a bump or knock will be heard in the loud speaker.

When tuned exactly to a station each IF circuit must be adjusted for optimum signal strength, for this will bring them into line with the crystal. The balancing condenser can then be adjusted for the deepest quality of reproduction, and this will usually coincide with *minimum* signal strength. If all be well, mistuning by equal amounts on either side of resonance will now result in the signals being equally diminished, but if the station disappears more rapidly on mistuning on one side of resonance than the other, it is a sign that the crystal balance is not exact, and Cn must be readjusted.

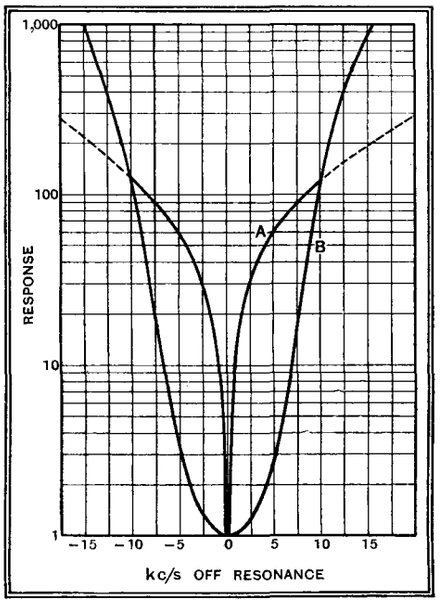


Fig. 3.—The type of resonance curve to be expected from a crystal is shown at (A), and that given by a number of ordinary circuits at (B). It can be seen that the latter is more selective at frequencies differing considerably from resonance, but less selective close to resonance.

The resonance curve of a typical quartz crystal operating at 1,600 kc/s is shown in Fig. 3 (A), and it can be seen that at 10,000 c/s the response is only 1/120 of that at resonance. To obtain this reduction with a tuned circuit the value of Q necessary would be nearly 10,000. It is actually difficult to build a circuit at this frequency with a Q greater than 200, and 100 is nearer the usual figure. With an effective series resistance of the order of 10,000 ohms, a Q of 10,000 means that the effective inductance is some 10 H and the capacity 0.001 $\mu\mu$F., values which it would be impossible to use in an ordinary tuned circuit.

The extreme selectivity given by the crystal leads to severe sideband cutting, and it is measurable even at such a low frequency as 50 c/s. Tone-correction in the low-frequency circuits is necessary to compensate for this, therefore, and the LF amplifier must give a gain which for frequencies greater than some 100 c/s is proportional to frequency. This is one of the major disadvantages of the crystal, for if correction up to 10,000 c/s be desired the LF gain must be 120 times the figure normally employed; for an upper limit of 8,000 c/s, 100 times is sufficient, and for 4,000 c/s, 50 times. In practice, the gain required will be about double these figures apart from any increase which is needed to correct for the sideband cutting of the tuned circuits, since it is not usually possible to obtain the correct shape of response curve without some sacrifice of maximum gain per stage.

It can be seen, therefore, that the use of the quartz crystal is likely to increase the cost of a receiver somewhat, for, in addition to the crystal itself, a considerable increase in the low-frequency amplification is necessary, while there is a loss in the crystal circuit itself. Largely on account of the damping imposed by the crystal upon the preceding tuned circuit, even when a step-down ratio is employed, the IF gain is very appreciably reduced. The increase in selectivity brought about by the use of a quartz crystal, therefore, must be paid for by an increase in the amount of amplification embodied in the receiver.

The Selectivity Obtainable

Now apart from considerations of this nature, we may enquire how a receiver embodying a crystal behaves in practice. In the first place, the tuning is extraordinarily sharp, much sharper than with an ordinary superheterodyne in which the same adjacent channel selectivity is obtained by means of a multiplicity of tuned circuits. This means not only that the tuning is more difficult, but that sideband screech is more prominent and the distortion caused by a small degree of mistuning is much worse. It is improbable that one could tolerate detuning by more than some 100 c/s, whereas with a normal circuit 500 c/s might not be objectionable. The oscillator used in the frequency-changer, therefore, must be much more stable than usual, and the maximum drift tolerable is not likely to be greater than 1 part in 16,000! This raises special difficulties in sets fitted with AVC.

On comparing the performance with an ordinary receiver of the same adjacent channel selectivity one finds that the selectivity of the crystal receiver is the lower for signals widely spaced from the wanted one. This is inevitable in any arrangement in which the major portion of the selectivity is obtained from a single highly selective circuit. For example, if one set has a single circuit giving a reduction to 1/100 at 10 kc/s off resonance and another has four circuits giving the same reduction, the response at 20 c/s is likely to be 1/200 for the single-circuit receiver, but something like 1/1600 for the four-circuit set.

In practice this means that unless the quartz crystal be associated with a number of fairly selective circuits of ordinary design, a powerful local station will spread more than it would do with an ordinary set of the same adjacent channel selectivity. This will be clear from Fig. 3, in which curve B shows the results to be expected from a number of ordinary tuned circuits, while curve A indicates

Single-Span Tuning and the Quartz Crystal— the performance of the crystal. The selectivity has been arranged to be the same at 10 kc/s off resonance, so that there is nothing to choose between the two as regards the elimination of a station on an adjacent channel (stations spaced by 10 kc/s are assumed for simplicity), and the crystal is as suitable as the tuned circuit receiver for the separation of stations of roughly equal strength. Neither receiver is sufficiently selective to permit a station spaced only 10 kc/s from a powerful local to be received free from interference, but the frequency separation at which the local does not interfere is greater for the receiver including the crystal than for the one which does not. The question is inevitably bound up with the shape of the resonance curve, and the curve for a circuit of high-Q will always cross the combined curve of several low-Q circuits. For frequencies nearer to resonance than the crossing point the high-Q circuit is more selective, but for frequencies more remote several low-Q circuits are better. In general, the latter condition applies to the restriction of the spread of a local, and the former to the elimination of interference from a station on an adjacent channel.

Special Characteristics

Compared with the results obtainable with the normal coils used in a single-span receiver and without any reaction, there is no doubt that the selectivity is very materially increased, although it is not quite as good as that given by the conventional superheterodyne and is of a different character. It is of the same order as that obtained with a single-span set in which critical reaction is employed.

The use of a crystal, however, gives one advantage over the conventional tuned circuits, and this is the ability to remove interference, including a heterodyne note and sideband splash, on one side of resonance by slightly deneutralising the crystal capacity. The resonance curve is then markedly asymmetrical and the quality of reproduction is consequently affected, so that a different degree of tone-correction is required and there is a possibility of harmonic distortion.

In view of this, and because of the lower efficiency and the necessity for extreme care in the adjustment of the balancing condenser, the quartz crystal is not considered suitable for general use at the present time. It nevertheless represents a fascinating field for the experimenter, and it may be as well to warn those contemplating a trial of the scheme that many of the quartz crystals available are unsuitable through possessing multiple resonance frequencies. They are satisfactory for the purpose for which they are intended, namely, for controlling oscillators, but not as resonators. The crystal employed must have only a single resonance frequency, and the writer has found that suitable specimens are obtainable from F. A. Best, of 21, Old Queen Street, Westminster, London, S.W.1.

American Television Tests

"Premature Standardisation would Freeze the Art"

By A. DINSDALE

AFTER having been "just around the corner" for a number of years, American television has at last reached the corner and decided to take a peep around it and see if it is safe to come out into the open. According to an announcement made by David Sarnoff, president of the Radio Corporation of America, at the annual meeting of shareholders held May 7th, television is to be taken out of the laboratory for field tests.

At first glance it may appear that America is anxious to catch up with Great Britain and Germany, but there is probably an element of commercial rivalry as well. R.C.A. has for years been developing the television system of Dr. Vladimir K. Zworykin, while the Philco Radio and Television Corporation has been sponsoring the system of Philo T. Farnsworth. Both systems would appear to be at about the same stage of development, so that whoever breaks into the commercial market first stands to win an advantageous position.

Mr. Sarnoff estimated that the campaign to introduce television commercially will cost one million dollars, and that between twelve and fifteen months will be required to prepare blue prints and complete installations. A start will be made in New York, using the Empire State building as the ultra-short-wave transmitting station. Experimental transmissions have been made between this building (the extreme top of which is 1,250ft. high) and the R.C.A. laboratories in Camden, N.J., ever since the Empire State building was completed nearly four years ago. Using a wavelength of approximately 6 metres, a range of about twenty-five miles is expected. This will cover centres of population aggregating something like twenty million people.

The second step in the programme will be the manufacture of a limited number of image receivers, which will be distributed among strategic points.

The third step will be the development of an experimental programme service to determine the most acceptable form of television entertainment.

R.C.A. Views

"Let me emphasise," said Mr. Sarnoff, "that, while television promises to supplement the present service of broadcasting by adding sight to sound, it will not supplant or diminish the importance and usefulness of sound broadcasting.

"In the sense that the laboratory has supplied us with the basic means of lifting the curtain of space from scenes and activities at a distance, it may be said that television is here. But as a system of sight transmission and reception, comparable in coverage and service to the present nation-wide system of sound broadcasting, television is not here, nor around the corner. The all-important step that must now be taken is to bring the research results of the scientists out of the laboratory and into the field." Mr. Sarnoff also said:—

"Important as it is from the standpoint of public policy to develop a system of television communication whereby a single event, programme, or pronouncement of national interest may be broadcast by sight and sound to the country as a whole, premature standardisation would freeze the art."

With New York as a nucleus, it is probable that, in time, other transmitting stations will be built which may be connected to the New York station either by wire or by wireless. The existing telephone lines, of course, cannot handle the frequencies involved, and the new hollow conductor type of high-frequency "cable" recently announced by the Bell Telephone Laboratories, while apparently satisfactory for the purpose, is extremely expensive and will take a long time to install in any extensive network form. For this reason, experiments are being made to determine the feasibility of relaying television programmes by means of ultra-short wave wireless relay transmitters.

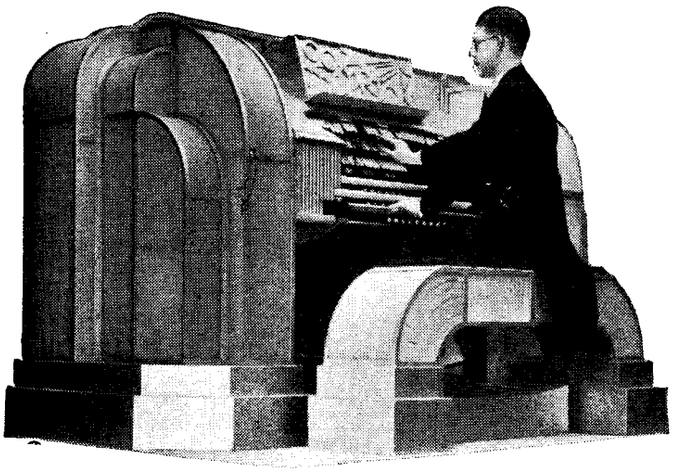
Does America Lead?

Mr. Sarnoff declared that the United States is further advanced in television than any other country, but admitted that many technical problems remain to be solved before the television broadcasting as a public service can be offered even over a limited territory. As to the present status of the art, Mr. Sarnoff explained that the degree of detail obtainable "is somewhat comparable in its limitations to what one sees of a parade from the window of an office building or of a world series baseball game from a nearby roof or of a championship prize-fight from the outermost seats of a great arena."

If this is the best that American television has to offer, and if America is really farther advanced than any other country, then the prospects of television, as entertainment, do not appear to be over-bright at present. However, a start must be made sometime, and it may be argued that broadcasting, as entertainment, was not so hot when that art was first introduced to the public. On the other hand, general technological development has progressed so far in the meantime that the public is now much more critical, and may not take kindly to a view of the Cup Final "from a nearby roof."

However, Mr. Sarnoff is at least maintaining his reputation for enterprise, and is to be congratulated on his bold step, which *somebody* had to be the first to take in the United States sooner or later.

Electrical Organ Tones



Technical Details of the Compton "Electrone"

SO many "electrical organs" have been experimented with that the musical public may fail to appreciate the possibilities of the "Electrone"—a new British development in the production of authentic organ tones by means of a comparatively simple arrangement of discs, amplifiers and loud speakers. This article describes how the "Electrone" obtains its unique sound effects.

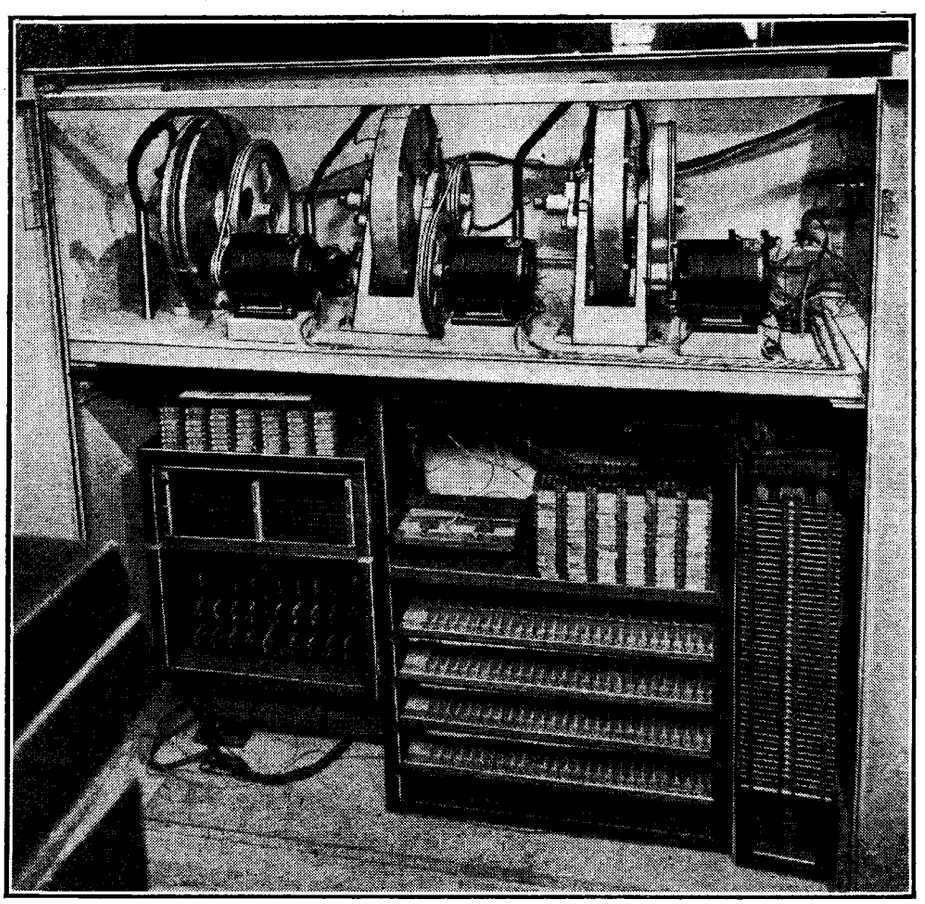
ALTHOUGH it is the token of a musicianly mind to disdain the cinema organ, probably 50 per cent. of the musicianly-minded nourish a secret interest in the tricks of tone colour which the modern cinema organ achieves. And nearly all musicians will evince interest in an entirely new electrical development in organ building which was demonstrated to *The Wireless World* last week by the designer, Mr. L. E. A. Bourn, at the works of the John Compton Organ Company, makers of the B.B.C. instrument at Broadcasting House.

The "Electrone," to use the tentative name of the new device, is at present restricted to solo purposes on cinema organs for the simple reason that a full compass of notes has not yet been attempted, but there seems to be no reason why the principles involved should not be embodied in a "church" organ to the complete exclusion of pipes. By the use of loud speakers, a valve amplifier and a metal disc revolving at constant speed, the "Electrone" builds up from pure notes a variety of tone colours which may seem incredible to those who have not heard the instrument demonstrated.

Controllable "Reverberation"

In addition to the Tibia, or near-diapason tone, which may be regarded as the foundation stop of all cinema organs, the "Electrone" produces startling imitations of the tones of harpsichord, glockenspiel, cor-anglais, chimes, harp, Hawaiian guitar (with "glide" effect), saw, vibraphone and other instruments. Effects of resonance can be introduced and controlled to give any required echo effect—an invaluable feature for organs in small rooms, cinema theatres, and other places which may be regarded as acoustically "dead"—and, moreover, it is possible by the adjustment of condensers and resistances to obtain a straight line response for any particular building in which the instrument may be installed.

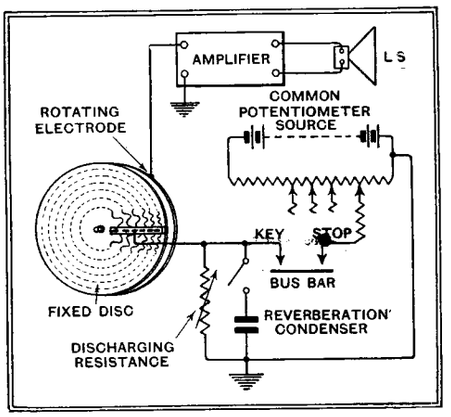
The chief advantage of the Compton system over the majority of earlier methods is that it dispenses with separate valve oscillators, photo-electric cells, etc., for the development of the tones. Sine waves of various pitches corresponding to the usual range of fundamentals and harmonics in the musical scale are engraved concentrically on a fixed insulating disc. The grooves are filled in with conducting material and contacts are brought out from each ring. A second disc revolving at constant speed and spaced about a millimetre from the first carries an exploring electrode which is connected to the grid of the first valve of a power amplifier of the usual public address type. If a constant DC potential is applied to the sine wave conductors in the fixed disc, an alternating voltage is induced in the revolving electrode, and by charging a group of rings simultaneously by the use of the usual organ "stop" relays any desired tonal quality can be built up. Not only are the strengths of harmonics adjustable relative to the fundamental, but the fundamental



Inside the "works" of the "Electrone" organ. The tone-generating discs are mounted above the keyboard and "stop" relays.

Electrical Organ Tones—

itself can be pre-set to compensate for irregularities in the loud-speaker response,



Schematic circuit diagram illustrating the basic principle of the Compton "Electrone" organ.

so that a perfectly uniform sound level is obtainable throughout the range of the instrument.

The simulation of reverberation effects is obtained by connecting padding condensers in parallel with the tone generator capacities. High resistances are connected between each ring and earth to dissipate residual charges which might otherwise lead to the discovery of unexpected "lost chords," and the time-constant of the added capacity discharging through these existing resistances gives the required "die-away."

Tremolo effects are achieved by mechanically rocking the fixed disc through a small angle, while the gliding tone of the Hawaiian guitar is reproduced by a relay which slows the driving mechanism while the hands are raised from the keyboard and allows it to return gradually to normal as soon as the next note or chord is played.

The "Electrone" is already being added to a number of organs in the larger cinema theatres in this country, and we imagine that the expression on the faces of some of our amateur organists when they hear a perfect *glissando* emanating from a keyboard instrument would make an interesting study.

Random Radiations

By "DIALLIST"

Not Ivinghoe Beacon

I HAVE lately come across the statement that if the Alexandra Palace is selected as the site of London's television station a relay may be installed on Ivinghoe Beacon, one of the highest points round London, which lies on the borders of Hertfordshire, Bedfordshire and Buckinghamshire. Though the position would be in many ways desirable from the technical aspect, since a view of thirty miles or more is obtainable from the top of the Beacon on clear days, I can say at once that this site will most certainly not be chosen for a relay station. The reason is that Ivinghoe Beacon is National Trust property, and I am quite sure the Trustees would never consent to the desecration of a beauty spot by the erection upon it of a transmitting plant. There are, however, several other high points where the Chiltern Hills end abruptly at the southern end of the great Vale of Aylesbury which would serve almost equally well for the purpose.

Multiple Relays for Flats

A REMARKABLE wireless relay system is being installed in a huge block of luxury flats in London. When it is finished the installation will serve over 1,000 flats in ten different buildings. Each flat will be provided with four-programme equipment, which means that the owner will have his choice of the Regional and National programmes and of two others provided at the discretion of the central station. I am wondering just how many occupants of the flats will avail themselves of the relay service and how many will prefer to use sets of their own. Personally, I should feel terribly cramped were I tied down to but four programmes. It would be rather like returning to the very old days of broadcasting. Most people who have used good modern receiving sets would be of much the same mind; but one has to remember that in some flats of modern construction it is by no means easy to obtain satisfactory results with a receiving set. An outdoor aerial may be out of the question, and in some buildings constructed largely of steel and other metals reception may be very poor if an attempt is made to use an indoor aerial or a portable set with built-in frame. The flat-dweller has his own special problems; the man who lives in a house is much better situated from the wireless point of view, and he knows what a blessing it is to be able to receive just such programmes as he fancies.

New Source of Interference ?

IF the use of ultra-short waves for the medical treatment of disease becomes at all general experimenters and others may be faced with a new source of interference with reception. It seems probable that both the sound and the vision portions of the high-definition television transmissions will take place on wavelengths between 6 and 7 metres, and these wavelengths, fortunately for sufferers and unfortunately, perhaps, for others, have been found particularly useful for the treatment of certain complaints. I don't imagine that the range at which interference could occur would be more than a few hundred yards; but even that might be sufficient to cause a good deal of trouble in thickly populated areas. Anyhow, it is a point which should be considered by the committee which is enquiring into interference, for it is always best to take time by the forelock in such matters. No doubt, by the use of no more power than is adequate for their purpose, and possibly of some kind of screening, these curative radiations can be prevented from inflicting suffering on users of ultra-short-wave receiving sets.

A Big Problem

One big problem, though, that will have to be tackled is that of the interference with ultra-short-wave reception that is radiated by certain motor car and motor cycle ignition systems. Some of them can be bad enough on the short waves, as anyone who endeavours to use a short-wave receiving set close to a main road must have discovered to his cost. Some years ago one make of car was a particular offender in this way. Your telephones or loud speaker told you of the approach of one of these vehicles when it was still some hundreds of yards away, and after the roar which marked its passing you went on hearing it for some time as it receded into the distance. There are not many of these old cars on the road nowadays, but one does still occasionally hear what used to be a familiar sound.

How the question of ultra-short-wave interference is going to be dealt with I don't know, but here again something should be done without delay, or the problem may present almost insuperable difficulties.

The He-Man Touch

SOME of us suffer in silence; others are men of action. My sympathies are distinctly with the man who, exasperated by the terrible racket of a neighbour's loud-voiced receiving set, armed himself with a hammer, burst into the house, and proceeded to set about the offending apparatus with shrewd blows that came straight from his heart. The sequel was a five-shilling fine and an order to pay five pounds as damages, but I can think of more than one case where the satisfaction obtained would have been well worth five guineas.

I would not, though, emulate the Parisian who, some months ago, shot the concierge of his block of flats as a protest against the appalling quality of the latter's loudspeaker reproduction. That is perhaps going a little too far.

A New Layer

AT one time we thought that the Heaviside Layer (or Kenelley-Heaviside, if you so prefer it), sixty miles or so above the earth's surface, was the sole reflecting envelope that our atmosphere contained. Then came the discovery of the Appleton Layer, more than twice as distant, which plays such an important part in short-wave transmission and reception. And now the American Bureau of Standards at Washington announces that eighteen months of experimental work have disclosed the existence of yet a third layer some 450 miles above the earth. So far it has not received a name, though once its existence is definitely accepted it will doubtless be called after its discoverer. It is believed that the new layer may be responsible for the quasi-visual range of ultra-short waves.

Short waves penetrate the Heaviside Layer and continue upwards to the Appleton; ultra-short waves, so far as can be seen, travel through both Heaviside and Appleton layers and are turned back to earth by the outermost reflecting envelope. I still can't help thinking that when more experimental work has been done with ultra-short waves we may find that there is a skip area beyond the optical range, and that the transmissions reappear at much greater distances.

UNBIASED

A Vulgar Deception

I WAS surprised to read in a foreign journal that certain enterprising theatrical managers in Great Britain, in a laudable effort to stimulate trade, are preparing an entirely novel show.

The idea is to throw on cinema screens silent moving pictures of actors going through the motions of plays which are being broadcast by the B.B.C. The voices of the actors and the musical accompaniments are, of course, to be provided by the actual actors in the B.B.C. studio through the medium of a receiver and the usual back-screen loud speaker.

Missed her cue.

There is something puzzling about the mentality of the foreign editor who prints stuff of this sort. He evidently fails to realise that to make the thing possible it would have to be done with the connivance of the B.B.C. as the script of the plays would have to be lent to the cinema people in order that the film might be made. Even I, with my knowledge and opinions of the B.B.C., cannot believe that the Corporation would stoop to anything quite so vulgar as this philandering with the cinema trade. Again, if the thing were done, it might as well be done properly and a complete talkie produced so that the show could be given repeatedly and at times more suited to the convenience of a cinema audience than those at which the B.B.C. usually broadcasts plays.

I could, in fact, scarcely imagine the experiment being tried even once as a stunt if I did not remember a piece of deception that was attempted by the manager of a provincial theatre many years ago when the B.B.C. first began to broadcast opera.

Hiring a crowd of 'umpteenth-rate "supers" at very cheap fees, he drilled them all in the action of the operas announced by the B.B.C. and then placarded the district with announcements to the effect that he had secured, at enormous trouble and expense, the services of a well-known Continental opera company. The performers went through the operas in dumb show, the music and words being picked up from the B.B.C.'s Covent Garden broadcasts and fed to the stage by cunningly concealed loud speakers.

The actors naturally waggled their lips in sympathy with the emanations from the loud speakers, but the whole effort was spoiled by the limitations of radio in those days. Although a first-class opera company was doing its stuff at Covent Garden the distortion *via* the crude wireless apparatus then available was so terrible that the dumb show actors would have made a better job of it if they had really given tongue themselves.

However, the trick might have deceived the natives had not the local prima donna missed one of her cues, with the result that her voice struck up before she appeared in the flesh.

Misunderstood ?

THE whole purpose of the vest-pocket set to which I made reference recently has, I fear, been entirely misunderstood by many members of the community. One man who states that he is an eminent explorer writes to support my plea that such a set should be produced by manufacturers.

"Oft times," he writes, "when trekking across the lonely Sahara or camping in solitude among the frozen Antarctic wastes I have felt the need for solace, and to be able to see the faces of my dear ones round the old fireside at home would amply compensate for the hardships I endure in these remote corners of our far-flung Empire."

Need for solace.

I can only suppose that my correspondent has been confusing my remarks with the prophecies of one of the special wireless correspondents of the daily Press concerning the proposed television service. At any rate, his expectations sound uncommonly like the extravagant forecasts of one of those misguided and irresponsible scribes who, by the complete misunderstanding of the Television Committee's Report, stampeded people into the belief that the days of the ordinary broadcasting receiver are numbered.

There are, however, other readers who have equally failed to understand me, and so I can only conclude that I must have been a little obscure, for "twenty thousand Frenchmen can't be wrong." Many readers in their zeal to be helpful to me have written to point out that it is possible to use headphones with any portable receiver if a little ingenuity is exercised. I thank them all the same.

By FREE GRID

There is, however, one thing I am very pleased to see, and that is that even if set manufacturers are still sleeping soundly, component manufacturers are not. Apart from midget valves, it is now possible to buy a 45-volt HT battery which measures only $3\frac{3}{4}$in. by $2\frac{3}{4}$in. by $1\frac{3}{4}$in. and weighs a mere $\frac{1}{2}$lb.

From Socket to Pocket

AS a result of the welter of information I received after my recent demand for a three-pin plug-adaptor, my opinion of the British electrical manufacturers has undergone a marked change for the better. If I have previously accused them of lack of enterprise, I humbly apologise.

Not only are plugs produced in all shapes and sizes but many firms have brought to my notice the fact that they produce adaptors whereby apparatus fitted with 5-amp. plugs can be used with 15-amp. sockets. At first I considered such adaptors redundant, as it occurred to me that the problem could be solved by fitting all apparatus with 15-amp. plugs.

My foolish ignorance in this matter might indeed have got me into serious trouble had not one firm been so kind as to enlighten me in a confidential letter as to the true reason for the production of this particular adaptor. It appears that the inspectors employed by the various electric supply authorities are liverish people of a suspicious nature, and if they find such articles as reading lamps fitted with 15-amp. plugs they are apt to put their own construction on the phenomenon.

It is, of course, a simple matter to whip the plug out of the socket as soon as the inspector is seen in the offing, but the evidence of the plug still remains, and it takes more than a minute to change that for a 5-amp. one. If, however, one of these special adaptors are used it is but the work of a moment to whip it out of the socket and conceal it in the pocket.

Current Topics

Events of the Week in Brief Review

Licence Increases

BRITISH radio licences in force at the end of April amounted to 7,055,464 as compared with 6,310,939 at the end of April, 1934, an increase of 744,525.

More Car Radio

NEARLY 5,000 cars and taxis in Paris are now equipped with radio receivers. Taxi wireless benefits broadcasting, as the owners must pay an annual licence of 100 francs in respect of each car.

Drama in Miniature

MANY visitors to the Universal Exhibition in Brussels are attracted to the ingenious diorama staged by the Comité Internationale Radio-Maritime, which re-enacts on a small scale the loss of the "Titanic." The exhibit reveals how greatly the perils of the ocean have been reduced by the introduction of wireless.

German Television Rivalry

HERR OTTO GEBÜHR, film star, appeared as Frederick the Great in front of the German P.O. television transmitter at Berlin on May 13th to inaugurate a regular service from that point to the P.O. building at Potsdam, a distance of thirteen miles.

There is some friendly rivalry in television questions between the broadcasting company and the Post Office. The company provides programmes three times a week, but the Post Office arranges television demonstrations every morning and afternoon as well as on alternate evenings.

Mystery Roof

AN expert of the Danish Broadcasting Company is to examine a mysterious house situated at a lone spot near the small town of Hobol. Passers-by, including the local constable, state that, although there is no radio receiver within a mile of the house, the Oslo programmes can be heard emanating from the slates all day long. At night, presumably because the roof is unselective, a number of foreign programmes are heard simultaneously.

The expert's solution of the mystery is being awaited with interest.

German Radio Show

THE German Radio Show will take place this year from August 16th to August 25th in Berlin.

Action Against Static

SINCE April 15th, when the French P.M.G.'s "static sleuths" got to work, no fewer than 5,660 sources of interference have been located, the owners of the apparatus being "invited" to comply at once with the official regulations.

No Place for Radio

A NEW threat to broadcasting is suggested by the news that the Spanish town of Toledo has been declared by the Government to be "historic," and, therefore, to be left in as close a state as possible to its aspect in the Middle Ages. Radio enthusiasts are hardest hit, for it is decreed that all aerials must be concealed, these being an anachronism in the mediæval landscape.

Radio Bandit Alarm

A RADIO firm in Walla Walla, Washington, is seeking a licence from the Federal Communications Commission for a novel radio bandit alarm. A bandit enters a bank flourishing a revolver, whereupon the cashier, simulating cowardice, pushes over a pile of coins which he offers to the marauder. The action releases an automatic switch held down by the pile of coins, sets a miniature radio transmitter in operation, and warns all the police cars in the vicinity.

Exit Radio Power

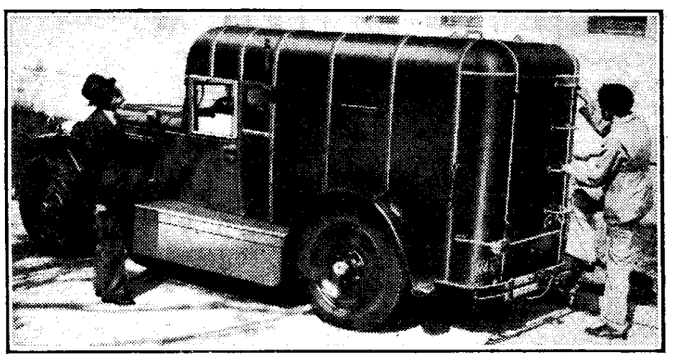
A GLOOMY meeting was held in Stockholm last week when the A.B. Glesum, the company formed a year ago to exploit Mr. B. von Platen's invention for the wireless transmission of power, was wound up. A capital of 750,000 kroner had been subscribed, all of which had been devoured by patent expenses and laboratory work.

Television with Tears

FRENCH journals are deploring the official television tests with 60-line definition, one journal declaring that "this affair can only cover our country with ridicule."

When Mlle. Beatrice Bretty, the actress who was first televised, referred to her embarrassment in being looked at by "the whole world," one of the journals remarked that this was a highly optimistic estimate. "It is doubtful," said the writer, "whether there were even a dozen television receivers peering at Mlle. Bretty."

The Government is urged to emulate the example of Germany and Britain by introducing 240- or 320-line television without delay.



TRAVELLING RADIO LABORATORY.—"Corkscrew" waves, progressing in spirals, can be transmitted from this new mobile unit of the Cruft Laboratory of Harvard University. The principal work at present is in the investigation of wireless echoes.

N.R.E.A.

A RALLY of the National Radio Engineers' Association will take place at 7.15 p.m. on Wednesday next, May 29th, at the Horseshoe Hotel, Tottenham Court Road, London W.1. All engineers in the trade are invited to attend a lecture on the subject of Frequency Changing Circuits.

London 5-Metre Tests

RAIN and high winds handicapped the 5-metre transmission tests by members of the International Short-Wave Club on the roof of *The Daily Telegraph* building in London on Sunday last. The station was in operation at 10 a.m., and very soon received reports from amateurs in London suburbs. From 10.30 to 11 G6SL at Birmingham was called, a beam aerial being used, but contact was not secured.

At noon a rain-storm drove the party off the roof, and the apparatus received some damage.

Signals were reported by G5LB, Beckenham; G5BB, Stamford Hill; G6SM, Croydon; G6NF, West Norwood; G6CW, Banstead; G2JB, Walworth; G5IS, Dulwich; Portable G6QB, Sanderstead; and G2AW, Keston. Both G6NF and G5IS were worked duplex.

The club transmitter consisted of a tuned-plate resonant-grid push-pull oscillator. The speech amplifier comprised two resistance-coupled stages, transformer-coupled to the modulator, and the power was 10 watts. The receiver was *The Wireless World* Ultra Short-Wave Two.

The club has not abandoned the idea of establishing an ultra-short-wave record, and, by kind permission of *The Daily Telegraph*, will repeat the tests on Sunday, June 2nd.

Birmingham Tests

THE ultra-short wave station, G6SL, which began transmissions last week, will shortly be testing with an omni-directional aerial to give Midland amateurs an opportunity of experimenting on five metres. The actual frequency of G6SL is 58 megacycles (5.171 metres). A schedule of weekday transmissions will shortly be issued. Reports should be addressed to Messrs. Stratton and Co., Ltd., Eddystone Works, Bromsgrove Street, Birmingham, 5.

North Downs Field Day

THREE transmitters will be in operation on Sunday next when the Thames Valley Amateur Radio Society conducts a field day on the North Downs. G6GB will be on Box Hill, Dorking, G5LC at St. George's Hill, Weybridge, and G2VV on the Hog's Back, near Guildford.

All stations will operate in the 40-metre band and a maximum power of eight watts supplied from batteries is stipulated. The contest commences at 12 noon and closes at 6 p.m., and five prizes will be awarded.

Reports, which will be welcomed and acknowledged, should be addressed to Mr. G. Billison, 84, High Street, Hampton, Middlesex.

Wireless and the Atmosphere

III.—The Ozone Layer, and Its Protective Action

By R. T. BEATTY, M.A., B.E., D.Sc.

THE Wireless waves which run along the earth are attenuated by their efforts to follow the curving surface and by the eddy currents set up in the badly conducting soil. At higher levels we meet the ozone layer which bends down waves of sound just as the Heaviside and Appleton layers bring down the wireless sky waves to earth.

THE previous article showed how the ground wave, the daylight wave which receives no help from the upper atmosphere, travels round the curving surface of the earth. So far we have regarded the earth as a perfect conductor, so that the attenuation is due only to progressive weakening of the ground wave by portions of it continually leaving the surface film and flying off into space, as raindrops are flung off a rapidly revolving wheel. Short waves are more attenuated than long waves because they cannot bend so easily.

We may note that, with such a copper-plated earth, waves could not penetrate into the ground, and an underground wireless set would receive no signals whatever. Actually signals penetrate to a depth of about one wavelength, as is known from recent researches carried out with a receiver in a mine 300 metres deep. Long wave signals were received down to a wavelength of about 400 metres, but waves shorter than this were unable to penetrate.

Absorption by the Ground

But the earth is not a perfect conductor, and the currents induced in it by the ground wave fritter away their energy by warming the soil. So we have here a further degree of attenuation which, while negligible for wavelengths down to twenty kilometres, becomes increasingly important as wavelength diminishes and is pronounced in the medium and short wave broadcast regions. T. L. Eckersley has worked out a theoretical formula which takes resistance into account and gives the signal strength at any distance from a station of known power and wavelength. His results agree excellently with signal strengths noted from Warsaw 1.4 km. experimental station, and also from the old Daventry 5XX, and with observations in the band 200-500 metres.

Typical figures for signal strength are given in Fig. 1[1] for (A) Warsaw, 1.4 km., 120 kW.; (B) a typical regional station, 300 metres, 50 kW.; (C) a short-wave station, 10 metres, 25 kW. It is evident that attenuation is greater with short waves. Thus the signal strength at a distance of 100 km. is reduced to a tenth of its value when we recede to 150, 260, 420 km. for wavelengths of 10 m., 300 m., 1.4 km. respectively.

Again, if we take an incoming signal of 0.01 millivolts/metre as the smallest value for useful reception (this depends of course on the type of receiver) we find limiting overland ranges of 200, 650, 1,450 km.

So much for the ground wave. During the noon hours of daylight in summer the high reflecting layers are out of action, and we must rely on the ground wave alone. It is reliable, does not suffer from distortion or fading, and has the sole disadvantage that its range is limited to a few hundred miles except in the long wave region. I really believe that we should all be much happier if we received ground waves only, unaccompanied by their rather temperamental companions which behave so oddly as they drop down from the night sky. Let us now resume our position at the top of the stratosphere—18 miles up (30 kilometres)—and before continuing our upward climb take a last glance at the scene below. The gulf beneath is full of wireless waves of all sorts of wavelengths, but we may be sure that short waves, say, 100 metres in length, which may reach us at this altitude will never reach earth again except by reflection from some high ionised layer. For we are 300 wavelengths up, and any wavelets sent down to earth will be completely cancelled by wavelets just out of phase sent down by neighbouring parts of the wave. For long waves, however, we are still bathed in the ground wave, for we are, for example, barely two wavelengths up, with respect to the 18 km. wave from Rugby.

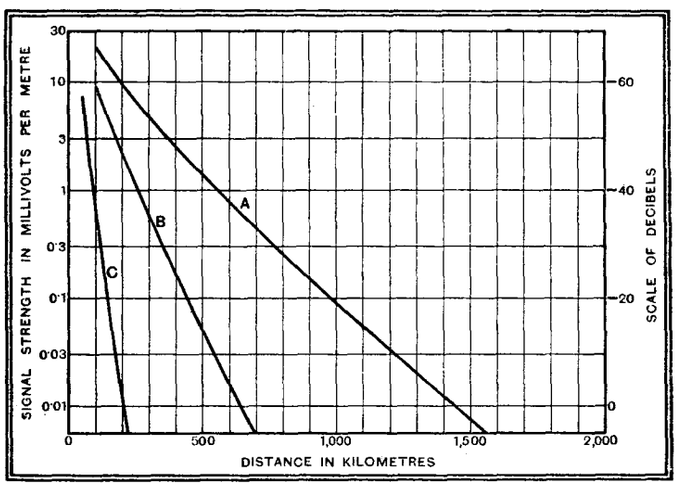


Fig. 1.—Attenuation of signal strength with distance according to Eckersley :—(A) Warsaw, 1,400 m, 120 kW. (B) typical regional station, 300 m, 50 kW. (C) short-wave station, 10 m, 25 kW.

The Ozone Layer

Now, as we continue our climb a surprise awaits us. The temperature is rising rapidly! The rise amounts to 10 deg. C. per mile, so that six miles above the ceiling of the stratosphere the temperature has risen from −55 deg. C. to 5 deg. above freezing point, and four miles farther up it is 45 deg. C.—a tropical heat.

The first suspicion as to this strange state of affairs came from the study of meteors. Meteors usually become visible at 60 miles up and disappear at 50 miles; they glow for a second or two with a brightness equal to that of a star of the first magnitude, and it is calculated that these little spheres of nickel-iron, only as big as small shot, radiate a power of 2 kilowatts during their brief incandescence, like a much overloaded pointolite lamp. This heat is due to friction in the air, and Professor Lindemann, of Oxford, calculated that if the air temperature above the stratosphere remained at −55 deg. C. the air would be too thin to give the frictional heat produced. But the required density of air could be obtained if the air were warmer, and so he predicted a summer heat above the stratosphere.

It may seem wrong to talk of hot air being denser than cold air, for air expands with heat. But if the atmosphere were very cold the air would shrink to a thin layer round the earth, so that there would be very little at a height of sixty miles. Any rise of temperature would cause this layer to expand upwards, so that the density, though smaller at ground level, would be greater at sixty miles.

Now, it is known that a layer of ozone forms the ceiling of the stratosphere, extending from eighteen to twenty-four miles; there is not much of it, for if it

[1] In Fig. 1 the earth's resistivity is taken as 10^{13} e.m.u., i.e., 10,000 ohms per cubic centimetre.

Wireless and the Atmosphere—

were all collected and brought to ground level the layer would be only three millimetres thick. But its absorption of ultra-violet light is so strong that it cuts a complete gap in the U.V. solar spectrum, and, indeed, absorbs 6 per cent of the whole solar radiation. Here, then, we have the reason for high temperature in this region of air.

Wireless Waves in the Ozone Layer

This layer is probably ionised, judging by the ionisation which is produced when we make ozone in the laboratory by exposing a flask of oxygen to ultra-violet light. It is the first of the ionised layers which we meet on our upward journey, and we naturally enquire whether it acts as a reflector of wireless signals.

The reply is that no reflection has yet been detected from the ozone layer. No doubt the ionisation is so slight that only very long waves are affected—longer than are used to-day in signalling.

But it reflects waves of sound.

Reflection of Sound Waves

It has been established without doubt in recent years that sound may travel twenty-five miles up into the air and come down again. Sound travels more quickly in warm than in cold air (a rise of 100 deg. C. increases the speed by 16 per cent.), so that on entering a warm layer the wave bends downwards like a beam of light entering a glass prism. For a long time it had been known that sound behaved strangely in the atmosphere. The noise of a great explosion had been noticed to die away to zero at a distance of sixty miles and then to reappear at about 120 miles. But it was only when Lindemann deduced from his work on meteors that high temperatures exist above the stratosphere that meteorologists guessed the reason for this zone of abnormal audibility.

An example is shown in Fig. 2. The sound at first curves upwards, since, in the troposphere the temperature is steadily falling. In the stratosphere the temperature is constant and the curve becomes straight. In the ozone layer the rising temperature refracts the waves and they finally come down 120 miles away.

A heavy gun fired at Shoeburyness was heard at Birmingham, 132 miles away. The time for travel along the surface should have been 620 seconds, but the actual time was 726 seconds. This delay of 106 seconds means an extra path of twenty miles, due to the long curving flight above the stratosphere. Similar results were obtained when a great ammunition dump was exploded at Oldebroek in Holland. Though in the long flight to England the waves of audio frequency were attenuated below the human audible threshold, yet the longer waves which carried most of the energy undoubtedly reached the eastern counties. In Cambridge at the calculated moment windows rattled, dogs barked, and birds flew screaming from the trees.

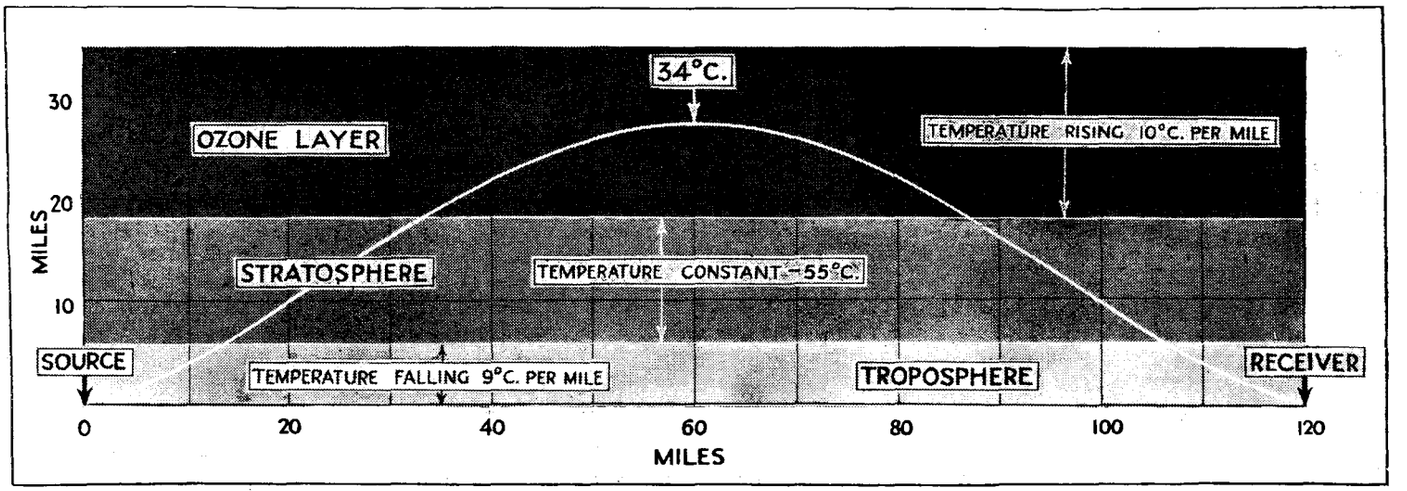


Fig. 2.—Abnormal travel of the sound of gun fire, due to refraction in the ozone layer.

A Heaviside Layer for Sound

In the reflection and refraction of sound by the ozone layer we have a remarkable analogy with the behaviour of wireless waves in the Heaviside and Appleton layers, which exist at much greater heights. But the mechanism is quite different: in the former case we have sound going faster when warm air is encountered, in the latter wireless waves go faster when the air becomes impregnated with freely moving electrons. There is, however, a general similarity in the effects produced in the two cases. Round the source a circular region extends in which the ground wave is audible: this is fringed by a zone in which nothing is heard, and beyond this silent zone or skip distance comes a terrain of abnormal audibility, due to waves dropping down to earth from mirrors set high in the sky. In the next instalment we shall analyse the behaviour of the mirrors which are responsible for the propagation of wireless waves over great distances; research during the last two years has made clear the main outlines, but many perplexing effects still remain to be accounted for.

Before we say farewell to the ozone layer let us realise that life on earth is shielded by it from harmful solar radiation. What, then, if the layer were destroyed by an increase in the amount of hydrogen in the lower atmosphere, which would combine with ozone to form water vapour. We should then be exposed to rays of the kind which a mercury lamp in a quartz tube emits. Eyes would be inflamed and blindness would rapidly attack us as the lens of of the eye became opaque; painful sores would break out on exposed skin, and probably all life which had not the wit to hide from the hostile sun would miserably perish.

BETTER SCREENED CABLE

A Detail Improvement in New Sets

SCREENED leads in high-frequency circuits are a necessary evil, but the sensitive wireless engineer must often be appalled by the excessive losses—and the needlessly high self-capacity — introduced by the shielded cable commonly used for the purpose. True, low-loss connectors with less self-capacity than usual are occasionally to be met with, but they seldom find their way into commercial sets, and are even difficult to obtain by the amateur.

In the Pye 1935-1936 sets improved HF connectors are to be used, in the form of a flexible metal shield enclosing an insulator of ceramic beads articulated on the crocodile-spine principle.

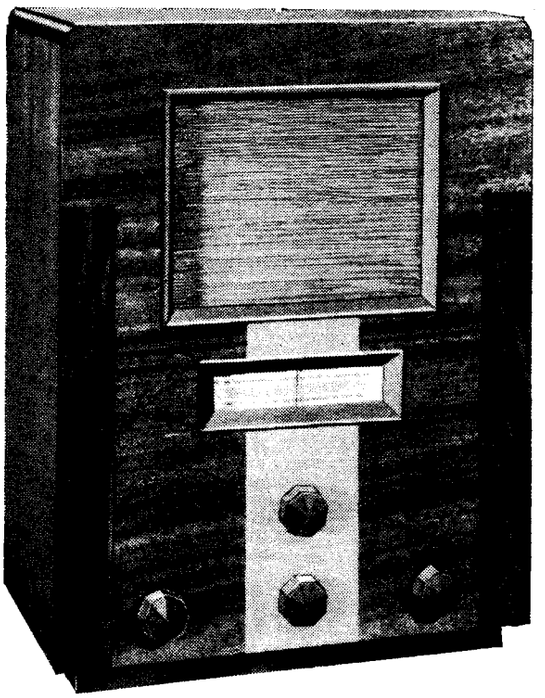
FUTURE OF CAR RADIO

Effect of Ministry's Announcement

A STATEMENT recently issued by the Ministry of Transport to the effect that no ban is to be placed on the use of radio sets in motor cars has apparently reassured many motorists who have hitherto hesitated to install receivers. According to Ekco, orders for their car sets have increased by over 150 per cent. since the statement was issued.

Special arrangements are being made to train engineers in the fitting of these sets, and E. K. Cole, Ltd., are planning for double their normal installation facilities throughout the present summer.

It is expected, too, that British car radio will find a ready market on the Continent.



LOTUS Model 66

A Universal Receiver with a Three-valve "Straight" Circuit

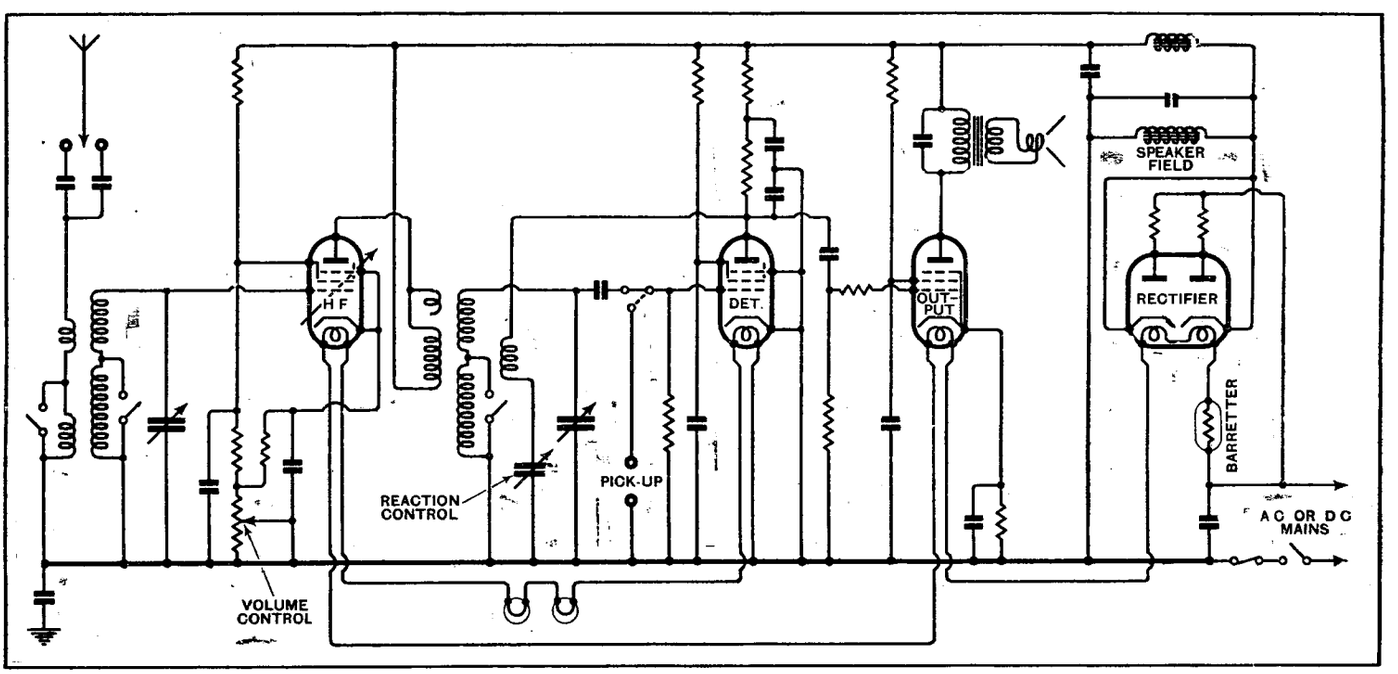
**FEATURES.—*Type.*—*Table-model straight receiver for AC or DC mains.*— *Circuit.*—*Var.-mu pentode HF amplifier—pentode grid detector with reaction—pentode output valve. Half-wave valve rectifier.* Controls.—*(1) Tuning. (2) Volume and on-off switch. (3) Reaction. (4) Waverange and gramo. switch.* Price.—*8 guineas.* Makers.—*Lotus Radio (1933) Ltd., 105, Judd Street, London, W.C. 1*

IN view of the popularity, both with manufacturers and the listening public, of the superheterodyne principle, it is interesting to find one of the new universal receivers employing a simple three-valve straight circuit. Although the superheterodyne may be expected to give a higher degree of selectivity, it is equally true that the straight circuit with a single HF stage is capable of giving sufficient selectivity for the needs of the very large section of the listening public who are interested primarily in the reception of the local programmes with a few foreign stations as a matter of interest. Sets of this type also have the advantage of being free from second-channel interference trouble, and, of course, the reduced cost of manufacture enables the set to be sold at an attractive price.

The three Triotron receiving valves in the Lotus Model 66 are all of the pentode type. The aerial input circuit consists of a single tuned circuit coupled inductively to the aerial. There are alternative aerial sockets, each associated with series condensers to give two degrees of selectivity and range. The valve in the HF amplifying stage is a variable-mu pentode in which volume is controlled by a resistance which is common to both the cathode and screen-grid circuits. The mains on-off switch is operated by this volume control in the minimum position, and is connected in the negative mains lead. A fuse is also included on the receiver side of the switch at this point.

The detector is an ordinary H.F. pentode operating on the leaky grid principle and receiving its input from the HF stage through a transformer employing a combination of inductive and capacitative coupling. A reaction coil is coupled to the HF transformer, and the degree of reaction is controlled by a variable condenser connected on the low potential side of this coil. It is unusual to find provision for a gramophone pick-up in universal receivers, but this feature is incorporated in the Model 66 and a switch associated with the wave-range control disconnects the detector grid from the HF circuit and at the same time short-circuits the grid leak.

The detector is resistance coupled to the pentode output valve and a simple by-pass condenser from the anode in conjunction with a series resistance in the grid of the output valve are relied upon to suppress

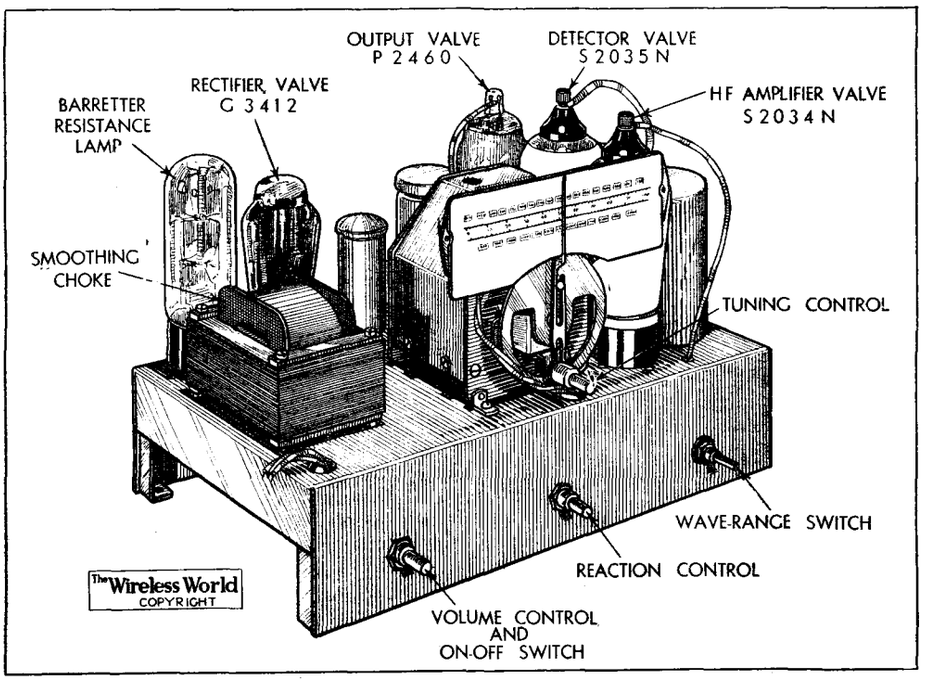


Pentode valves are used throughout in the straightforward three-valve circuit. Provision is made for the addition of a gramophone pick-up.

Lotus Model 66—

HF leakage. A fixed degree of tone control is provided by the connection of a fixed condenser across the primary of the loud speaker input transformer. There is no provision for an external loud speaker.

The rectifier valve is of the type in which separate cathodes are associated with each anode. In the receiver tested both sections of the valve were connected in parallel, the loud speaker being joined across the main HT supply. As an alternative, however, the cathodes may be separated, one circuit being employed to energise the field and the other to supply the HT current to the set. In the latter case the resistances in series with the anodes are omitted and an additional electrolytic condenser is connected across the field winding. Two pilot lights of the 0.3 amp. type are connected in series with the valve heaters, the current in this circuit being controlled by a Philips Type 1928 barretter resistance lamp. The range of control is such that the receiver may be plugged into mains with any voltage from 150 to 250 without adjustment.



There is no mains voltage adjustment as the barretter automatically adjusts the heater current over a range of supply voltages from 150 to 250 volts.

Quiet Background

The receiver was tested both on DC and AC mains of approximately 230 volts, and it was interesting to note a momentary flash in the pilot lights on first switching on the set, due to the slight time interval required for the barretter to reach its equilibrium temperature. Trouble from mains noise is not to be anticipated, and the set was particularly quiet on the AC supply.

The sensitivity of the receiver is very little less than that to which we have become accustomed in four-valve superheterodyne circuits, and, in favourable circumstances as regards selectivity, the more powerful Continental stations are easily received without having to call upon reaction. Without reaction, however, there was considerable spreading of Droitwitch on long waves and the London Regional programme on medium waves.

Best results were obtained by a judicious balance between the reaction and volume controls, and for maximum selectivity reaction must be increased and the volume control reduced to bring the station back to the required volume level. With reasonable attention to these adjustments no difficulty should be found in separating, for instance, Fécamp from the London National transmitter and Cologne from the North Regional station when the set is operated in the London area. Similarly, there was no interference from Droitwich when receiving Radio-Paris, even when the latter station was not modulating. Reception of the Deutschlandsender, at least as regards selectivity, was just beyond the capabilities of the set.

When receiving the local programme the volume control must be turned down as much as possible, as otherwise overloading of the detector and double-hump tuning is apparent. Provided the receiver is properly tuned in this way the quality of reproduction will be found to be entirely satisfactory. The loud speaker is of comparatively small diameter and gives bright tone without an undue preponderance of bass. The fundamental resonance of the loud speaker appears to be somewhat higher than usual and encroaches on the lower tones of male speech. It gives satisfactory reinforcement of instruments of similar compass to the 'cello, but it would be unreasonable to expect it to reach the pedal notes of the organ or the lower strings of the double bass.

The veneered walnut and sycamore cabinet is attractive in appearance, and the horizontal tuning scale carries, in addition to approximate calibrations of wavelength, a degree scale, upon which the positions of one's favourite stations can be accurately noted. Although on the higher mains voltages the barretter lamp dissipates quite a considerable heat, the total power taken by the set is under 60 watts, and the general temperature inside the cabinet is rather below the average for a universal receiver.

Next Week's Set Review—
McMICHAEL MODEL 135

THE RADIO INDUSTRY

FOR the first time on record, public-address announcements have been reproduced by the B.B.C.; on May 11th, during the O.B. tour of the illuminated London areas, speech from Tannoy loud speakers on the police vans was broadcast.

The owner of the 7-ton yacht "Emanuel," who recently crossed the North Atlantic single-handed, has written to express his complete satisfaction with the reliability and service given by the Siemens Full-o'-Power batteries with which his Schooner wireless set was fitted. Another small yacht, the 8-tonner "Driac II," which has since made the Atlantic crossing, was similarly equipped.

Burne-Jones and Co., Ltd., have received orders from the "Wireless for the Blind" Fund for a number of one-valve and two-valve receiving sets of new design with an improved form of Braille tuning and switching.

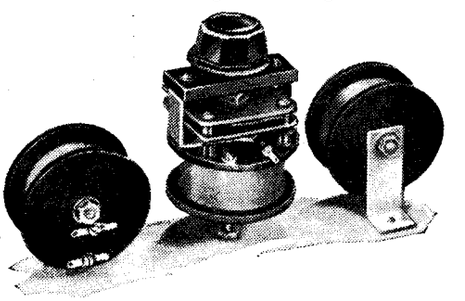
Mr. Cyril French, of 29, High Street, Hampton Wick, Kingston-on-Thames (Telephone: Kingston 2240), has been appointed the sole distributor and service agent for Celestion speakers to the wholesale and retail trades.

The various uses of the Berclif type H1 portable test oscillator are described in a pamphlet available from Berclif, Ltd., 38, Rabone Lane, Smethwick.

QA RECEIVER COILS

A SET of tone-correction and whistle-suppressor coils for the QA Receiver has been received from the London Radio Development Services, Ltd., of 56, Hazel Road, Kensal Rise, London, N.W.10.

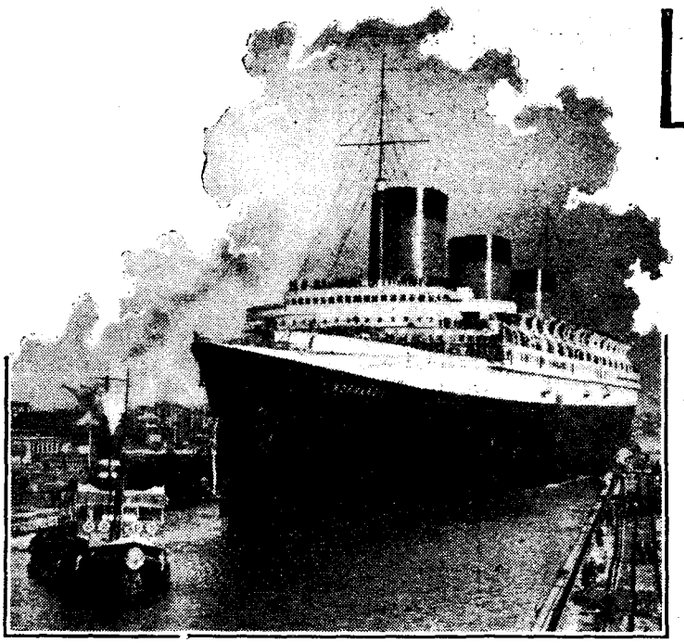
The two tone-correction chokes are priced at 5s. each, and are well constructed, being wound to specification. The whistle-suppressor coil is supplied not only with a bracket for mounting its tuning condenser



but with the condenser itself, and is listed at 8s. 6d. Here, again, the specification published in *The Wireless World* has been adhered to, and the components can be recommended for use in the receiver for which they are designed.

Listeners' Guide

Outstanding Broadcasts at Home and Abroad



MAIDEN VOYAGE. The great French liner, "Normandie," is scheduled to leave Havre on her first voyage to New York on Wednesday next, May 29th. Running commentaries will be relayed by all French stations as well as many in the American networks.

A ROYAL WEDDING

THE "O.B." season tends to be monopolised by the B.B.C., but this week two of the best outdoor events come from abroad.

To-day (Friday), from 11.15 a.m. to 3 p.m., Stockholm celebrates the wedding of Princess Ingrid of Sweden and the Crown Prince Frederick of Denmark. First will be heard the marriage ceremony from the Storkyrkan Church, Stockholm. Greetings and running commentaries on the celebrations at 1 p.m. and from 3.30 till 5 p.m. will be broadcast from Motala. Approximately at 5 p.m. there will be a commentary and sound picture of the departure of the Royal pair for their honeymoon on the yacht "Danneborg." Then, at 8 p.m., Kalundborg and Stockholm will broadcast a joint Swedish-Danish concert in their honour.

THE "NORMANDIE"

THE other noteworthy foreign "O.B." will be on Wednesday next, May 29th, when the French stations will broadcast a running commentary on the departure of the gigantic liner, "Normandie," from Havre on its first voyage to New York.

ALL ABOUT SPAIN

LETTERS from a woman to her author husband on the Riviera describing the picturesqueness of Spain to give him ideas for a book, is the theme underlying "Tango in Spain," to-night's romantic programme (Regional). The letters will, as it were, be set to music, and there will be melodies from Bizet's "Carmen," famous tunes by Granados, besides the tango music for which Spain and South America are noted. Denis Freeman is the producer and the B.B.C. Orchestra will be conducted by Mark H. Lubbock.

A MODERN CANTATA

MODERN cantatas deserving of public performance are even rarer than good dance tunes. To-night (Friday) from 8.15 to 9.10 all German stations will broadcast the "Marien-Kantate," Opus 99, by Graener. This cantata, which was composed in 1933, is for four solo voices, mixed choir, and orchestra. It includes ten vocal sections and an instrumental interlude—"Mater dolorosa."

30-LINE TELEVISION

Baird Process Transmissions.

Vision 261.1 m.: Sound, 296.6 m.

MONDAY, MAY 27th.
11.15—12.0 p.m.

"Victorian Modes and Melodies": —Lydia Sokolova (Prima ballerina of the Diaghileff Russian ballet), assisted by Harold Turner; Harold Scott and Maisie Seneshall (songs).

WEDNESDAY, MAY 29th.
11.15—12.0 p.m.

Sydney Jerome (syncopated piano solos); Laurie Devine ("Most Graceful Dancer"), Gus Chevalier ("The Blinkin' Fool"); Eric Fawcett (songs and dances), and Billy Franklin (musical comedy).

The libretto is made up from poems by various writers from the thirteenth to the seventeenth century. Graener's music, although belonging to the typical German tradition, is not church music in the narrow sense, though it deals with sacred themes.

ARCHBISHOP OF YORK

NATIONAL lectures are still rare enough to be "events." On Thursday next His Grace the Lord Archbishop of York, D.D., will give a National lecture on "Faith and Freedom" from 10.15 to 11 p.m. (Nat.).

EMPIRE DAY

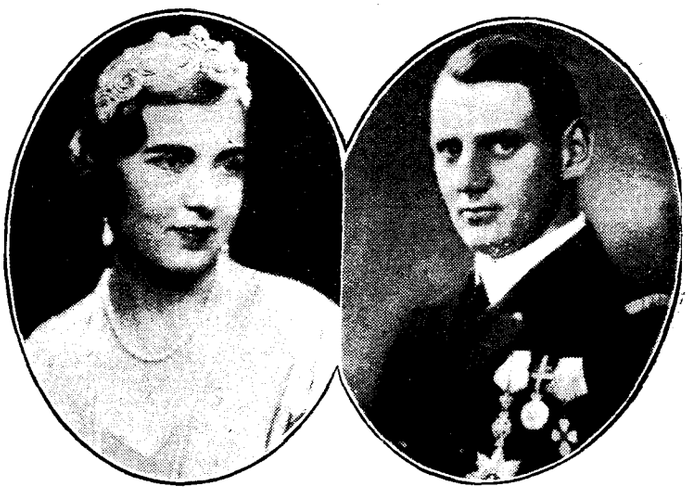
THE two highlights in to-night's Empire Day programmes are the relay from Hamilton, Ontario, with a message from the Prime Minister, the Rt. Hon. R. B. Bennett (Nat., 7.30), and the Royal Command Concert of British music given in the Royal Albert Hall in the presence of Their Majesties, the King and Queen.

The Canadian programme will be a dramatic presentation of the story of the foundation of Empire Day in Canada and will, in a sequence of vivid cameos, tell the Dominion's story since the United Empire Loyalists landed in old Nova Scotia in 1783.

The great Albert Hall concert will be provided by representatives of nearly 170 festival choirs from all parts of Great Britain, and very appropriately the programme will cover all phases of British music from "Sumer is Icumen In" (thirteenth century) to Sullivan's "Yeoman of the Guard" and modern works by Vaughan Williams and Roger Quilter.

WEDDING BELLS

A PHILIP WADE radio play is always worth noting in the listening diary. He is the author of "Wedding Group," a drama to be broadcast on Tuesday next, May 28th (Nat., 8) and on May 29th (Reg., 8.45). The story takes us back to the days of the Crimean War and tells of the love adventures of two young Scottish people.



ROYAL WEDDING BROADCAST. H.R.H. Princess Ingrid of Sweden who to-day (Friday) will be wedded to H.R.H. the Crown Prince Frederick of Denmark. In addition to a broadcast of the church ceremony from Kalundborg and Motala at 11.15 a.m. there will be special relays throughout the day.

The youth, a medical student, wishes to become engaged to the girl, but she, in the best dramatic tradition, suggests that he should propose again next year. Meanwhile she goes off to the Crimea as a nurse under Florence Nightingale. Their letters are intercepted, but, after some sticky intrigue, the pair are united.

Sophie Stewart will be heard as Janet Graham and Joyce Bland as Florence Nightingale.

e for the Week

OPERA

IN honour of the Scandinavian Royal Wedding, Kalundborg is to relay Act I of Wagner's "The Valkyrie" from the Danish Royal Theatre at 8.30 on Tuesday next.

Another interesting opera broadcast comes from Brussels No. 1 from 8 to 10 p.m. on May 30th, when a performance of Ganne's "Les Saltimbanques" by the Radio Orchestra and Choir will be relayed from the Universal Exhibition. On the same evening Paris P.T.T. will broadcast from 8.30 to 10.30 "Le petit bois," a one-act operetta by Grisart; a selection from "Dédé"; a three-act operetta by Christiné, and "S.A.D.M.P.," an opéra bouffe in one act by Beydts with words by Sacha Guitry. This is good measure for one evening.

COMMAND PERFORMANCE FROM COVENT GARDEN

COVENT GARDEN opera gives a Command Performance on Wednesday next, May 29th, of Rossini's "Barber of Seville" in the presence of Their Royal Highnesses the Duke and Duchess of York. Act I of the opera will be broadcast (Nat.). The artistes will include Aristide Baracchi, Heddle Nash, and Lily Pons.

THOSE CHILDREN

"WINNIE'S HOUR" may not be so formidable as it sounds, for the variety entertainment with this title, to be broadcast on Monday next, May 27th (Reg.) has been devised by Harry Hemsley. Present in the studio will be Harry Hemsley's famous radio children, Winnie, aged 4½; Elsie, aged 7; and Horace, too young to mention. Supporting the family will be Clarice Mayne, Rupert Hazel, and Elsie Day, Webster Booth, Billie Baker, Harry Hemsley (would you believe it?) and Leonard Henry.

FOLK MUSIC

SWABIAN folk music will be broadcast to-night (Friday) in a concert from Stuttgart by the Karl Kromer Choral Society from 10.30 to midnight. There will be a professional wind band as well as a peasant band, and Hans Thaler filling in with his accordion.

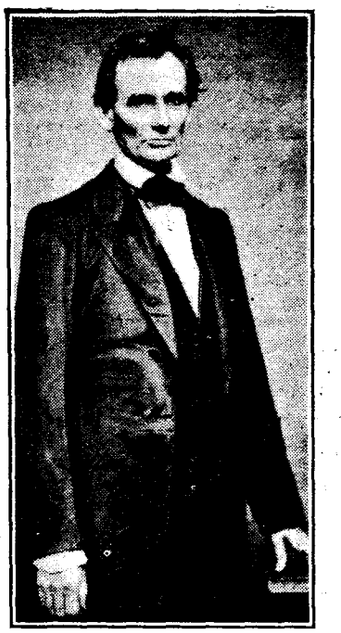
"ABRAHAM LINCOLN"

A SERIES of radio plays on Sunday evenings is an innovation for which we must thank the Midland programme director, who has arranged radio versions of the plays by various reperterory companies in the area.

The first is on Sunday next at 9.20 (Reg.), when the Birmingham Repertory Company will perform John Drinkwater's famous "Abraham Lincoln," by arrangement with Sir Barry Jackson.

Playgoers will remember that Drinkwater, in a number of vivid and forceful scenes, tells the story of the last five years of Lincoln's life, working up to the climax of the President's assassination in a theatre lounge on April 14th, 1865. The part of Lincoln will be taken by Stephen Murray. To help listeners in following the action of the play Elspeth Duxbury will take the part of Chronicler. Herbert E. Prentis and Val Gielgud will be the producers.

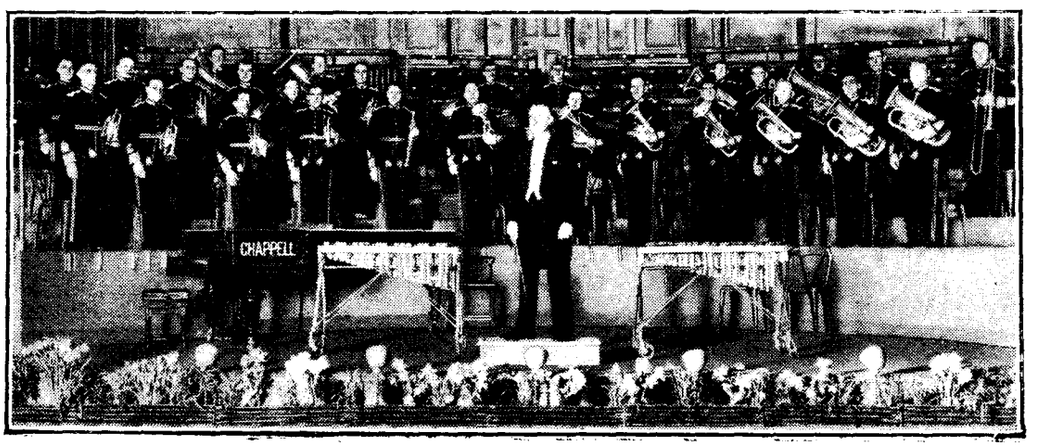
CALLENDER'S SENIOR BAND, one of the most popular brass combinations, will be heard to-morrow evening in the London Regional programme.



"ABRAHAM LINCOLN," John Drinkwater's famous play, will be broadcast Regionally at 9.20 p.m. on Sunday. Above is a reproduction of an actual photograph taken shortly before Lincoln's assassination.

BACH IN JOVIAL MOOD

THOSE who look upon Bach only as a sober-minded composer of sacred music should tune in next week's "Foundations of Music." Continuing the Bach festival celebrations, there will be performed some of the secular cantatas with the aid of a Chamber Orchestra. On Monday we can hear the wedding cantata, "Vex No More, Sad Melancholy," and on Wednesday Adrian Boult conducts the orchestra in the jolly Peasant Cantata, "We Have Got a New Squire Master Here." THE AUDITOR.



HIGHLIGHTS OF THE WEEK

FRIDAY, MAY 24th.

Nat., 7.30, Canadian Empire Day Programme. 8.35, Royal Command Performance in the Albert Hall.
Reg., "Tango in Spain." ¶Talk: "Among the British Islanders," by Gerald Heard.
Abroad.
Budapest, 7.30–10.45, "Don Giovanni" (Mozart), from the Opera.

SATURDAY, MAY 25th.

Nat., Music Hall. ¶Italian Music by the B.B.C. Theatre Orchestra. ¶Henry Hall's Guest Night.
Reg., Callender's Senior Band. ¶American Half-hour. ¶Harp Recital by Marcel Grandjany.
Abroad.
Huizen, 9.40–11.10, K.R.O. Boys' Concert.

SUNDAY, MAY 26th.

Nat., Eugene Pini and his Tango Orchestra. ¶J. H. Squire Celeste Octet. ¶Celebrity Trio. ¶B.B.C. Theatre Orchestra.
Reg., B.B.C. Orchestra (E), conducted by Joseph Lewis. ¶Nonsense Music by Stuart Robertson (baritone) and Hely Hutchinson (pianoforte). 9.20, "Abraham Lincoln."
Abroad.
Vienna, 8.20, Operetta "Polenblut" (Nedbal) by the Vienna Symphony Orchestra, Choir and Soloists.

MONDAY, MAY 27th.

Nat., Schumann Recital by Cecil Dixon (piano). 8.30, London Music Festival Concert. Conductor: Koussevitzky.
Reg., "From Hill and Prairie"—B.B.C. Northern programme. ¶"Winnie's Hour," with Harry Hemsley and Leonard Henry.
Abroad.
Warsaw, 9, Symphony Concert by the Station Orchestra.

TUESDAY, MAY 28th.

Nat., 8, "Wedding Group." ¶"Freedom," by Erwin Schrödinger. ¶Leslie Bridgewater Quintet.
Reg., Entertainment Hour with "The Roosters," etc. ¶B.B.C. Theatre Orchestra: Light French Music.
Abroad.
Paris (PTT), 8.30, Victor Hugo Concert with National Orchestra and Choir.

WEDNESDAY, MAY 29th.

Nat., 8.15, Covent Garden Royal Command Performance: "The Barber of Seville," Act I. ¶Regimental Marches by Wireless Military Band.
Reg., Beethoven Pianoforte Recital by Frank Merrick. 8.45, "Wedding Group."
Abroad.
Brussels II, 9, Concert by the Station Orchestra.

THURSDAY, MAY 30th.

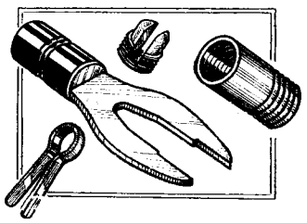
Nat., Radio drama, "Bound Away" (from Glasgow). ¶Music Hall. 10.15, National Lecture by Archbishop of York.
Reg., Wireless Military Band. 8.25, "Schwanda the Bagpiper," Act I, from Covent Garden.
Abroad.
Radio-Paris, 8.45, Symphony Concert by the National Orchestra.

New Apparatus Reviewed

Recent Products of the Manufacturers

CLIX SPECIALITIES

TWO new items of interest have been added to the long list of Clix specialities made by Lectro Linx, Ltd., 79a, Rochester Row, London, S.W.1. One is a new Master Plug of slightly heavier construction than the earlier pattern, the new model being designed to fit a ¼in. socket, whilst the special wire grip will accommodate an insulated flex cable $\frac{3}{16}$in. in diameter. This plug will fit the standard valve-holder socket, and



Clix heavy-duty spade terminal and new model Master Plug.

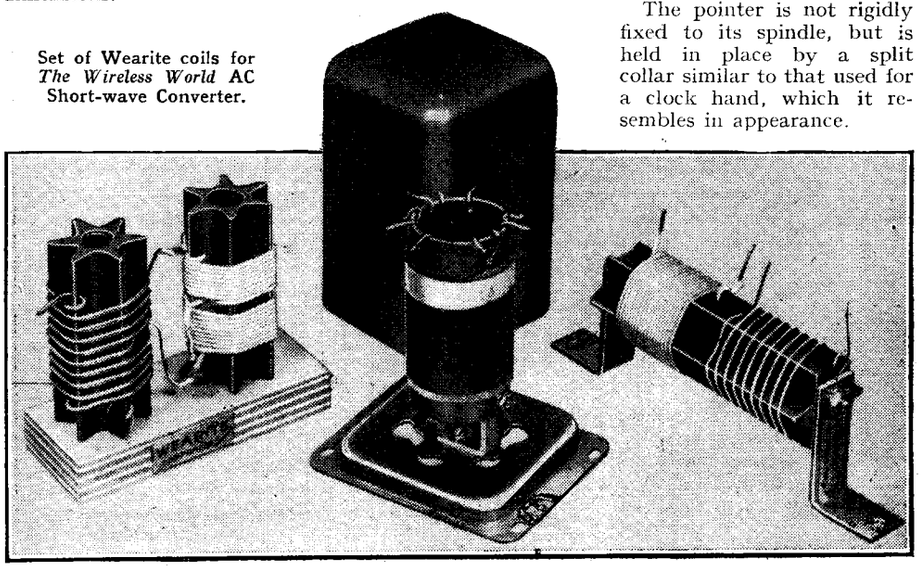
makes a very good electrical connection; the prong is nickel-plated, and it can be obtained with a red or a black insulated bead, the price being 3d.

The other new addition is a non-corrosive spade terminal designated a heavy type. The slot is so designed that it fits comfortably under terminals with shanks of from ⅛in. to $\frac{3}{32}$in., while the wire grip will take a cable of $\frac{3}{16}$in. diameter overall. It can be obtained with the metal parts lead-coated for use with accumulators or nickel-plated for other purposes, and the price is 3d.

SHORT-WAVE CONVERTER COILS

WRIGHT AND WEAIRE, LTD., 740, High Road, Tottenham, London, N.17, have submitted for examination a set of coils for the AC Short-wave Converter described in *The Wireless World* of April 12th and 19th last. These comprise the aerial assembly, oscillator coil and special IF transformer, the latter being mounted and enclosed in an aluminium screening box with a detachable cover of the correct dimensions.

Set of Wearite coils for *The Wireless World* AC Short-wave Converter.



All three coils are exceptionally well made and exactly to the specification in every detail. They can be confidently recommended for use in this set, and the prices are 3s. for the aerial asembly, 3s. for the oscillator coil, including its mounting brackets, and 5s. for complete IF transformer as illustrated.

Formo new dual-ratio condenser drive, scale and escutcheon for panel or baseboard mounting.

FORMO DUAL-RATIO "SNAIL" DRIVE

A NEW condenser drive embodying several interesting features, including a dual-ratio reduction mechanism in which the pointer travels through 270 degrees for 180-degree rotation of the condenser, has been developed by Formo Products, Ltd., Mason's Hill, Bromley, Kent. Thus, it provides a much more open scale than usual, and is especially suitable for receivers of the Single-Span type and also for short-wave sets. This dial fits any single or gang condenser having a ¼in. spindle and a fixing bush of ⅜in. diameter.

Provision is made for mounting the drive either on the baseboard or on the front panel; in the latter case the condenser would be supported by the drive, and a fairly rigid panel will be necessary. A valuable feature is that the baseboard mounting bracket is adjustable for height, and the condenser spindle can be set any distance above the baseboard from $1\frac{5}{16}$in. to 2⅛in.

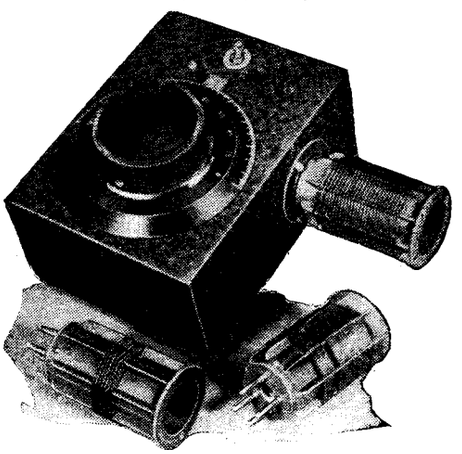
There was no trace of backlash or slip in the specimen tested, the drive being smooth and perfectly satisfactory with all types of condensers; the coarse drive gives a reduction of 8 to 1, while the vernier control is approximately 50 to 1, and the pointer travels in the same direction as the rotation of the knobs.

The pointer is not rigidly fixed to its spindle, but is held in place by a split collar similar to that used for a clock hand, which it resembles in appearance.

With this drive a special scale is needed, of course, though this is not included with the mechanical unit, but sold separately together with the pointer, and an attractive moulded escutcheon; a lamp-holder is supplied also. The drive costs 3s. and the complementary parts 3s. 6d.

EDDYSTONE S.W WAVEMETER

A SHORT-WAVE wavemeter that can be used either as an absorption meter or buzzer excited has been introduced by Stratton and Co., Ltd., Eddystone Works,



Eddystone short-wave wavemeter and coils.

Bromsgrove Street, Birmingham, 5. It is a very neat and compact unit, being assembled in a stout die-cast metal case with the condenser dial on top and the coil inserted into a socket on one side. Four-pin interchangeable coils are used, and three suffice to cover a wave-range of 10 to 225 metres with an adequate overlap on each.

The instrument is band-calibrated, and a set of curves is supplied giving the range of each coil, their respective coverages being 10 to 29.6, 29 to 88.6, and 80 to 225 metres. This wave-length calibration was found to be accurate and reliable on test, for there is no backlash in the condenser, and as the buzzer excites the tuned circuit from a separate winding, the calibration is unaffected with the buzzer circuit interrupted.

This method of excitation gives a very sharply tuned note. The signal is not strong though adequate when using a sensitive receiver, but can be obscured if a bad background from local interference is present. Under these conditions wavelength checking could be effected by using the instrument as an absorption meter.

The price complete is £3 3s.

National Television Plans for Germany

Service of Twenty-one Stations Proposed

BERLIN has already started a regular television transmission on the basis of 180 lines and 25 pictures, and the Berlin Post Office has made arrangements whereby the public can attend demonstrations so as to see for themselves what the new service has to offer. The well-known technical journal "Electrische Nachrichten-Technik" recently published a very interesting article by W. Scholz, describing the German television proposals for a fuller development of the service and for extending it to cover the whole of Germany. In the following article is given an account of the German plans based on a translation of the paper by W. Scholz.

THE television service which is projected for Germany is one giving both television and the accompanying sound programme: to use the convenient German "portmanteau" word, it is a "Tonbild" (sound-sight) service, and the writer begins by pointing out the advantage of using two wavelengths as close together as possible, one for "sound" and the other for "sight." By this plan not only is the reception of the combined programmes made easier (a single heterodyne generator serving for both) but also similar conditions of propagation are ensured for the two transmissions.

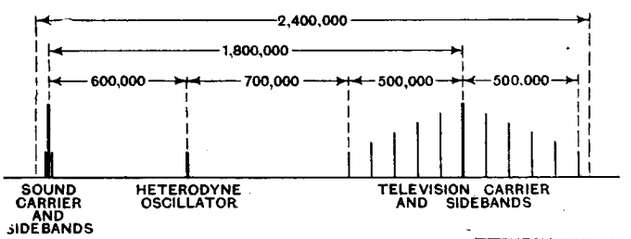
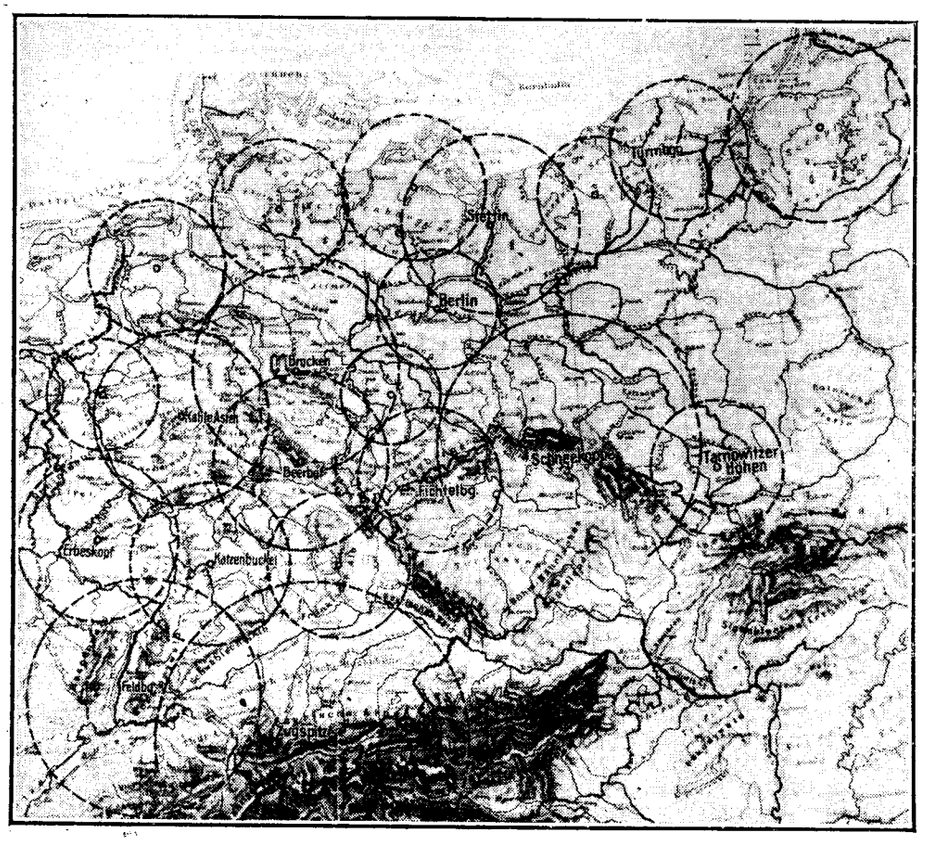


Diagram showing how the frequency bands are to be utilised.

The necessity for the use of the ultra-short waves below 9 or 10 metres, at any rate for the high-quality television service required (180 lines, twenty-five pictures per second), is explained on the grounds that the picture carrier frequency must be from ten to one hundred times as high as the maximum modulation frequency sent out (say, 500 kc/s), and that the "short" waves above 10 metres—although they would comply with this requirement—are unsuitable for the service owing to fading and other irregular propagation. Taking as an example of a suitable ultra-short wave-band the waves between 7.5 and 5.7 metres, the writer shows that five complete sound-sight transmitters can be fitted into this band without mutual interference, each station being allowed a total band of 2,400 kc/s for its combined sight and sound programmes, with a "safety gap" of about 50 kc/s on either side. The way in which this station band is utilised is shown in the accompanying diagram, which illustrates the simultaneous reception of both the sound and sight programmes by the use of a common heterodyning frequency.

The next and most interesting point is the range of such a station according to its power and to the height of its aerial. In the early days of ultra-short waves there was an inclination to regard these waves as so similar to light waves that they would only be propagated as far as the "optical path"; that is, that the receiving aerial could not lie below the horizon as seen from the transmitting aerial. Recently, however, this view has been modified, even for the much shorter "micro-" waves from 1 metre downwards—as witness the results of Marconi in obtaining ranges, with wavelengths such as 57 cms, far exceeding the optical distance; but although qualitatively it has been realised that the working range of, say, a 7-metre wave could exceed the optical range, quantitatively there is still a good deal of vagueness. Herr Scholz sets himself to remove this by means of a theoretical discussion of the propagation of waves between 2 and 10 metres, backed by the results of tests carried out by the German Post Office on the Berlin (Witzleben) wave of 6.985 metres. The following conclusions are reached:

Waves between 2 and 10 metres do not differ fundamentally in their propagation from the short waves of 10 to 200 metres and the longer waves above 200 metres. The reason why early tests, with the small-power transmitters and comparatively insensitive receivers then available, gave the impression that the ultra-short waves were only propagated in straight lines and did not (like the longer waves) manage to follow the earth's curvature, is that the damping effect of the ground (which comes into action at all wavelengths as soon as the waves bend round the earth and are thus no longer pure "space" waves) increases strongly as the



Map showing the proposed locations of stations and their service areas.

National Television Plans for Germany—

frequency increases, and is, therefore, very high for the ultra-short waves. In the early tests, therefore, it was only natural that the signals could not be detected beyond the horizon.

Actually, the equation for the field strength E in volts per metre, produced at a range of r metres, over unimpeded country by a transmitter radiating W watts, is $E = 9.5\ (\sqrt{W}/r) \times e^{-ad}$, where e is "exponential e" (2.718 . . . .), a is a constant depending on the wavelength and the nature of the ground, and d is the length of path over which the wave has to follow the curvature of the earth—that is, the difference between the total range r and the two "horizon distances," one as seen from the transmitting aerial, and the other as seen from the receiving aerial if this, also, is raised. In this equation the last factor is equal to unity so long as r does not exceed the optical range, since d is then obviously zero; but as soon as bending with the earth comes into the case its value changes markedly from unity, the tests leading to the conclusion that over flat country a is roughly 0.1 per kilometre for waves around 7 metres in length. To take an example given in the paper, the field strength of 6 mV/metre produced by a certain transmitter at a distance of 42 km (the limit of its optical range) would be multiplied by $e^{-0.1\times18}$ at 60 km, since the curved path d would then be 60 − 42, or 18 km; that is to say, the 6 mV/metre would be reduced to 0.7 mV/metre by those extra 18 kilometres. This example makes very clear the enormous importance of a high transmitting aerial—since the height of receiving aerials is obviously very limited in practice; and it is this fact which forms the guiding principle in planning the system for the whole of Germany which the writer now outlines.

Twenty-one Stations to Cover the Reich

In this plan it is assumed that a minimum field strength of 1 mV/m has to be provided, and that the transmitters will have aerial powers ranging from 2 to 20 kilowatts, on wavelengths from 7.5 to 5.7 metres. The great height of transmitting aerial is to be provided by erecting high towers where necessary, but wherever possible still greater heights are to be obtained by making use of mountain peaks, such as the Brocken (in the Harz Mountains, and celebrated for its "Spectre") and the Zugspitze (Bavarian Alps). In this way it is reckoned that heights ranging between about 450 and 8,000 feet can be obtained, the lower heights being compensated for by the use of the higher-powered transmitters. Thus the Brocken, with a height of about 4,000 feet, might have 2 kilowatts in the aerial and would then give a range of roughly 85 miles, calculated by the equation given above. By ringing the changes of height, power, and wavelength (keeping always within the 7.5 to 5.7 metre band, or at most going down to 5.5 metres to allow a sixth station in each group) it is thought that the whole of Germany can be provided with field strengths of at least the 1 mV/m by means of some twenty-one to thirty stations, with ranges between about 60 and 120 miles; the illustration shows a map of the Reich covered with little overlapping circles, each circle representing the extreme working limit of one of the stations proposed. The five or six non-interfering wavelengths would be so distributed geographically among the total number of stations that no mutual interference would arise.

It must be remembered that these calculated ranges assume a receiving aerial in free air (as, for instance, on the roof of a building), and do not allow for the weakening effects produced when reception is on the lower floors of a block of lofty buildings in a large town. The tests were extended to investigate these effects, and it was found that in the worst cases the field strengths might be reduced to a tenth of the calculated value. On the whole, however, the results were reassuring. It is contemplated that the reception in large towns which have not got a "main" station to themselves might be improved by providing a relay station, on a wavelength below the main wave-range (*i.e.*, below 5.5. metres), for such a town. Since these relay stations would not be required to cover great distances, the extra damping due to the higher frequency would not matter.

The difficulties liable to arise in connecting the studios with transmitting stations situated at heights of thousands of feet are only touched on in the present paper, but from other sources it is known that tests have been carried out regarding the use of a radio link to a receiving station on the Brocken; so that if the difficulties of a cable link to a mountain transmitter are found insuperable, such a wireless link would presumably be used.

Distant Reception Notes

300 Miles on a Crystal Receiver

READERS have probably noticed the amazing strength of the Poste-Parisien, the 60-kilowatt Paris station which works on 312.8 metres. In my house, which is some 30 miles north-west of London in one of the Chiltern valleys, this station is receivable after dusk on a crystal set. As the crow flies Paris is almost exactly 300 miles from my home. Curiously enough, the crystal receiver will have nothing to do with any medium-wave B.B.C. stations, except the London Regional and National, though the Midland, Western and Northern transmitters are well within the 300-mile radius and the Scottish "Twins" are not very far outside it. Nor will it bring in Athlone on 531 metres, though the distance from this station is within a few miles of that from the Poste Parisien and the two are rated at precisely the same output power. One might have expected Athlone to come in the more strongly of the two owing to its longer wavelength, but this is distinctly not the case.

Speaking of Paris stations reminds me that experimental television transmissions have recently been made from that city's P.T.T. station on 431.7 metres. What with these and the Eiffel Tower's efforts in the same direction on 176 metres, the French Ministry of Posts and Telegraphs appears to be doing its best to give the new hobby every chance. I am afraid, though, that the response in that country may not be found too good, except amongst amateur experimenters. France has ever been strangely backward in the number of "broadcast" receiving sets in use, and one can hardly think that television transmissions will produce widespread enthusiasm.

Some of these new high-powered transmitters seem to take a long time to get into action after announcements have appeared that they are complete to the last terminal. The 150-kilowatt Motala station appears to be at work on occasional evenings, but I have heard nothing yet of Radio Roumanie, to which the 1,875 metre wavelength belongs under the Lucerne Plan. Other newcomers which ought to be in operation, though they have yet to be recorded in the log, are Toulouse P.T.T. and Lille.

I am glad to see that the Swiss Federal authorities have banned advertising from their programmes. The French Government is supposed to have done the same thing, though in that country the prohibition does not yet appear to be in full operation. The sponsored programme, as conducted in America, is comparatively inoffensive, for there each item is merely introduced by a few words from the announcer to the effect that listeners are indebted to some particular firm for what is to follow; but advertising as done by some European stations must be terribly boring to those who rely mainly upon them for their wireless entertainment. I don't know whether my sales resistance (I believe that is the technical term) is specially high, but I am sure that if I were told evening after evening to buy umbrellas made by somebody or boots made by somebody else I should certainly see to it that my money was spent with neither of these firms.

Listening to American transmissions in winter time no longer provides the thrill that it once did, since almost any set can bring in quite a number unless conditions are distinctly unfavourable; I don't know whether enthusiasts realise that several stations in the United States and in the Argentine can still be received in the small hours. I don't advocate sitting up specially for the purpose, but if you happen, for any reason, to be up late it is well worth while to spend a few minutes in running over the band of waves between about 220 and 350 metres. My own record summer-time bag of American stations was made a year or two ago when I was confined to bed with some silly illness.

Unable to sleep, I switched on the wireless set that stood on the bedside table and succeeded in identifying a round score. Such was the elation produced by this feat that I was up and about again in record time. Clear proof, I think, of the healing effects of radio waves, of which we have heard so much of late. D. EXER.

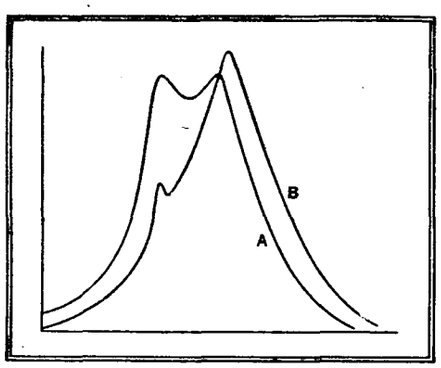
HINTS and TIPS

Practical Aids to Better Reception

Trimming Band-pass Filters

COMPARATIVELY few amateurs possess the necessary apparatus for preparing resonance curves of band-pass filters, such as those shown in Fig. 1. Nevertheless, by the intelligent use of an ordinary detector anode current meter (or, in the case of a modern superheterodyne, of a tuning indicator in the anode circuits of the controlled valves) a very useful mental picture of what is happening may be obtained.

That something approaching the ideal resonance curve A has been attained is recognised quite readily by the behaviour of the indicating instrument. As the tuning control is rotated steadily and very slowly through the position corresponding to precise resonance with an incoming carrier wave, a rapid rise in strength will take place (corresponding to one of the "skirts" of the curve). Next, for an appreciable space there will not be any noticeable change in intensity; the dip at exact resonant point is not clearly perceptible with ordinary instruments. Lastly, there will be a rapid decline of the signal.



A good idea as to whether a band-pass filter is giving the ideal resonance curve A, or a lop-sided one like B, can be obtained by carefully watching the tuning indicator.

A certain indication that the trimming condensers of the filter are incorrectly adjusted is obtained when the all-too-common lop-sided curve B is obtained. In this case, tuning on one side of the point corresponding to maximum signal will appear to be much flatter than on the other, but, as a rule, the kink shown on the left-hand side of the curve will not be clearly detected. Further, the desirable broadening of tuning on each side of the resonant point will not be evident.

Curve B indicates beyond doubt that alignment is incorrect and that readjustment of the trimming condensers is advisable, both in the interests of selectivity and quality of reproduction. This applies to band-pass filters both in signal-frequency and IF circuits, and if a really good job is to be done without elaborate instruments the trick of shunting each of the component circuits with a resistance (of about 50,000 ohms) is to be recommended. The value of resistance suggested will be suitable in average circumstances, but if circuit efficiency is high, resistances of greater ohmic value may be advisable.

Makeshift Tone Control

ONE of the easiest ways of temporarily reducing high-note response for minimising whistle interference—or for that matter for any other reason—is to reduce the amount of decoupling in the LF amplifier. This applies to a number of popular circuit arrangements, although in some cases it may be necessary to reverse the connections of the LF transformer primary.

To put the scheme into practice it is merely necessary to substitute a smaller condenser for that employed for decoupling, say, in the detector anode circuit. In this way LF reaction is provoked and its effect will be more marked at low frequencies than at high. Incidentally, the purists will insist that this scheme does not attenuate high notes, but accentuates low ones, which is not quite the same thing. They are right, of course, but by combining judicious use of the volume control with a reduction of decoupling the desired effect is obtained.

Although open to criticism, the method suggested gives very passable results in many cases, and has the advantage that it may easily be put into effect. Where it proves to be entirely satisfactory, a tone-control system may easily be devised by arranging to switch in alternative values of decoupling condenser.

Battery Makers on "Old-school Traditions"

ACCORDING to the *Chloride Chronicle and Exide News*, a journal published by the well-known battery makers, many of the teachings of a few years ago regarding batteries have proved to be erroneous, or else modifications in the manufacture and design of batteries have vitiated their force.

For instance, the idea that a short-circuit implies ruination of the plates is fallacious; a battery may be discharged at any rate within the carrying capacity of the internal conductors without harm.

Another fallacy: after filling cells with acid the first charge must commence at once, or the plates will have a very short life. No permanent harm arises even if a cell is allowed to stand for a day or two after filling before the initial charge begins. Indeed, cells with wood separators should be filled with acid a considerable time before applying the charging current.

Preventing Voltage Rise

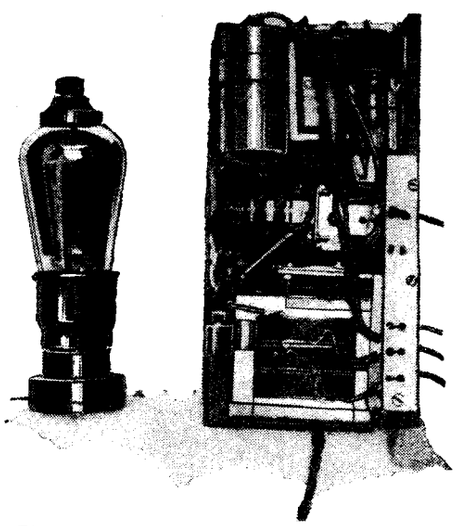
MOTOR-GENERATORS or rotary converters of the type used for operating AC receivers from DC mains are usually well regulated, and, as a result, no undue voltage rise is to be anticipated even if the receiver consumes appreciably less wattage than that at which the machine is rated. But, when the rating of the machine is several times greater than the anticipated power consumption of the set to be worked from it, there is no harm in taking reasonable precautions and, as a preliminary measure, the AC output of the generator may be connected to a higher tapping on the transformer than the rating would indicate.

For instance, a converter rated at 240 volts output would be connected to the 250-volt terminals in the receiver.

The Safety Limit

IT is well known that accumulator cells should not be discharged below the limit of 1.8 volts per cell. But it is worth while to remember that if this limit has been accidentally exceeded, no great harm will have been done if the cell or battery can be placed on charge immediately. Any delay is almost certain to cause the plates to become sulphated and their efficiency impaired.

AMATEUR-BUILT MIDGET SET.



The extreme compactness of this 3-valve HF-det.-LF receiver, recently shown at a meeting of the Golders Green Radio Society by Mr. W. L. Pattullo, can be gauged by comparison with an ordinary valve. The set measures 6in. by 7in. by 4in. and works with a frame; Hivac midget valves are used.

Broadcast Brevities

By Our Special Correspondent

Empire Broadcasting Surprise

TO be guilty of under-estimating the importance of a forthcoming event is a crime not often imputed to this Special Correspondent; but this time the accusation will not be denied.

Last week I hinted that the power of the Empire stations would be more than doubled. Actually it appears that the power may ultimately be nearly quadrupled, so that at last the British short-wave stations will be able to make their voices heard as strongly as the foreigners.

The British Kilowatt

There is something splendid about the way in which the B.B.C., during the last two years, has tried to keep level with foreign competition and to make the voice of the Homeland hold its own among a jumble of discordant voices while using less than half their power.

The B.B.C. have now learnt that, despite the Duke of Wellington, a British kilowatt is not equal to two French kilowatts, or four Dutch kilowatts, or eight Russian kilowatts, and so on.

Nominal and Actual

At present Daventry works on 20 kilowatts. When the new transmitters open the power will nominally be raised to 50 kilowatts, and may even climb to 75 kilowatts.

I will not spoil the story by adding that Paris (Radio Coloniale) will soon be working on 100 kilowatts.

B.B.C. and Parks Loud Speakers

THERE is no enthusiasm at Broadcasting House over the proposal that loud speakers relaying the B.B.C. programmes should be installed in all the London parks.

Even the most cheery-looking and flower-bedecked loud speaker putting out, perhaps, a 100 watts speech is a poor substitute for a score of military bandsmen, as the Union of Perambulating Nursemaids will agree.

Dull Uniformity

But there is another disadvantage—in London, at any rate—in resorting to the loud speaker idea, for it is one of the attractions of the Metropolis on a summer evening that you can hear one band in the Green Park and another in Hyde Park. Broadcast reception would mean a dull uniformity, unless Hyde Park gave talks while the Green Park restricted itself to musical programmes.

Mass relaying of B.B.C. programmes also raises important questions of copyright.

Talk from Braille MS.

A TALKS innovation occurs on June 4th when an almost blind mat-maker, Mr. John Moore, will contribute to the series on "Freedom." Mr. Moore will read his script from Braille, and this will probably be the first time that a speaker before the B.B.C. microphone has used this method. The talk will deal with freedom from the point of view of the working man.

Pilsudski's Only Broadcast

IT was soon after the *coup d'état* in 1926 that the late Marshal Pilsudski was prevailed upon to broadcast to the Polish people, and the circumstances were, to say the least, unusual.

MARSHAL PILSUDSKI photographed at the microphone with his little daughters in the Belvedere Palace in December, 1926. In civilian dress immediately behind the Marshal is Dr. Chamiec, now Director-General of Polish broadcasting.

Before giving his message, the Marshal was surrounded by his officers and civilian supporters, but he asked that all should leave the studio except his two little daughters, who sat, one on each side of their father, during the address.

Marshal Pilsudski used no manuscript, but told a homely fairy tale which contained some shrewd political allusions.

Glasgow v. Edinburgh

GLASGOW has never really forgiven Edinburgh for depriving her of her broadcasting status. In the early days 5SC (Glasgow) was the fountain head of Scottish broadcasting, and it was only as a sop to enraged Edinburgh listeners that a puny relay station was opened in the capital some years later.

But Edinburgh's turn came when the B.B.C. decided to erect headquarters in the Scottish capital to control the new transmitters at Falkirk; since then Glasgow, deprived of her own transmitter, has steadily declined in broadcasting importance.

Bigger Staff

There are, however, brighter days in store for the Clydeside city. At a cost of £50,000 the B.B.C. will soon acquire and refurbish a section of the Glasgow University buildings, which will be transformed into an imposing broadcasting studio with modern control equipment.

It is probable also that the staff, which at present numbers only eight members, will be enlarged to cope with the Corporation's ambition to increase Glasgow's contribution to the broadcasting programmes as a whole.

John Watt for U.S.

NO one will grudge John Watt a holiday. When I last talked with him he told me that he had produced twenty-four shows in three months.

Very shortly he will proceed to the U.S.A. not only to recuperate but to search for new ideas and fresh talent. Possibly he may be heard in American broadcasting, but his main idea is to absorb any features and formulæ which may prove of use to British radio.

Both England and America can learn much from each other in broadcasting matters, and these interchanges of visits are all to the good of radio on both sides of the Atlantic.

Seriously Ill

HERBERT JONES, the famous Royal jockey, will, on June 1st, come to the microphone to describe some of his early experiences.

Jones tells an amusing story of his introduction to wireless when in hospital at Newmarket suffering from pneumonia. It was in the days of crystal sets. When very ill he picked up the headphones, and the first thing he heard was the "News Bulletin" in which it was announced that the B.B.C. regretted that Herbert Jones the jockey was lying very seriously ill and was not expected to recover.

This brought him to his feet in no time.

Russian Dress in the Studio

"THE RED SARAFAN," which scored a success when it was heard for the first time on May 7th, will be broadcast again on June 18th. The orchestra for this production is now a permanent combination, and will be heard in all the "Red Sarafan" broadcasts.

In the last broadcast Captain Sorokin introduced his Siberian Cossack Choir, and for the next broadcast he will bring his Russian Tzigany Choir, which is a mixed formation, the girls wearing Russian Tzigany costumes and the men their national dress.

Taxi!

THERE is a taxi rank outside Broadcasting House, and one of its most regular drivers, Ernest Dixon, was heard some time ago in "In Town To-Night." Possessing a fund of stories and anecdotes collected during thirty-five years of driving in London streets, he so impressed the authorities that he was introduced to the "mike."

On June 3 a feature will be introduced to the programmes called "Variety in a Taxicab," and Ernest Dixon will act as *compère*, in that he will be sent in his taxi to convey to the studio various artists suited to the taxicab programme.

Broadcasting in Gaelic

LIKE the B.B.C. the Irish broadcasting organisation has its little worries. Sir John Reith's life since 1922 has been punctuated with attempts to mollify Welsh deputations pleading for an all-Welsh transmitter; now it looks as if Dr. Kiernan, the new Irish broadcasting chief, is to suffer in the same way. Deputations are being got together with the slogan that "the time is ripe for the establishment of a Gaelic broadcasting studio in Galway as the capital of the Gaeltacht."

Seconds out of the ring!

HF Chokes: Construction and Performance

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

Behaviour of the More Ambitious Specimens Tested

(Concluded from page 488 of May 17th issue)

THIS instalment deals with the performance of chokes in which special efforts have been made to avoid the presence of absorption points in the broadcast wavebands; also with the question of undesirable interaction with other windings and methods of preventing it.

THE observant reader of the first instalment of this article will have noticed that all types of chokes, even those with equal sections, appear to have one more or less bad absorption region in the medium waveband. The results of tests with many types have shown that the wavelength of this is roughly a quarter of the natural wavelength, where the equivalent capacity is zero.

Therefore, to avoid such a fault between 200 and 540 metres, the natural wavelength should be rather below 800 or rather above 2,160 metres. The latter is perhaps preferable, to ensure satisfactory operation on the long waveband, but the inductance required is about 0.38 henry, and a 800-metre choke offers less difficulty and is more likely to be suitable for short waves, without being seriously inductive on long waves (for the stray circuit capacity brings its working resonance up to about 2,000 metres or more).

Unwanted External Couplings

Another disadvantage of high-inductance chokes is that they couple strongly to power transformers, smoothing chokes, coils, and such components, and are liable to introduce hum and various forms of instability and interaction.

It would, therefore, be a very pleasant thing if, without sacrificing any other good points, our choke could be largely devoid of external field. There are several ways of minimising the field. One is to make the coil small. It may be objected that a smaller coil must have a larger number of turns for a desired inductance and that therefore it is no less liable to couple. But, while the coupling is proportional to the area of a turn and the number of turns, the inductance is proportional to the area of a turn and the *square* of the number.

For example, if one choke has 1,000 turns each 2 inches in diameter, another 1 inch in diameter must have about 2,000 turns for the same inductance. But each turn is only a *quarter* the area of those in the large coil, so that, although there are double as many of them, the coupling effect is half as great. This policy is consistent with low capacity, but is limited by allowable DC resistance.

Then there is the well-known "binocular" idea. Two identical coils are placed side by side, and connected so that the field due to one is opposed by that due to the other. Two varieties of this type were tested by measuring the mutual inductance with a standard coil at certain definite positions and distances. Thus, while at 9 inches the mutual inductance with A and B is 74 microhenries, and with E no less than 216, with F and G it is 15 and 8.5 respectively. In both F and G, identical equal-sectioned coils are spaced 1½ inches apart, but, whereas F has an inductance of 0.17 henry, that of G is only 0.074. The DC resistance of F is necessarily rather high—nearly 900 ohms, for the separation and opposition of the two halves necessitates more turns for a given inductance.

That the binocular principle is not inconsistent with useful characteristics in other respects is shown by the fact that samples F and G were superior to any of the preceding ones, except that the inductance of G was rather inadequate on long waves, the capacity being – 20 m-mfd. at 2,000 metres. It is the better of the two on short waves, with a capacity of 2 m-mfd. to the 3.5 of F. On medium and long waves their equivalent resistance is a megohm or higher, and there are no "dead-spots," except for a slight lapse at about 220 metres on the part of G.

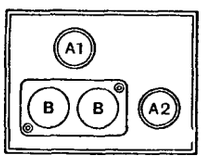


Fig. 4.—Illustrating the possibilities of coupling between a binocular choke BB and other coils.

If both halves of a binocular choke are at equal distances from another coil, their couplings are in opposition and balance out exactly. But if the choke is close up it may happen that one section is considerably nearer than the other, and only partial balance is obtained. In Fig. 4, if BB is a binocular choke, and A1, A2 are other coils, it is clear that the coupling to A1 is zero, but the coupling to A2 is quite large.

To get over this difficulty, we must so arrange the two choke portions that they are always the same distance from everything. The two portions can be made concentric. The coupling is then not *quite* zero if the other coil is very close, but it is a great improvement in this respect on the binocular.

The method is to wind a reversed section of wire round the inner main winding of small diameter, making the two portions equal and opposite as regards external field. Thus, if the reversed winding is double the diameter of the inner winding—and therefore four times the enclosed *area*—one-quarter the number of turns is effective.

Chokes adopting this principle, but otherwise similar to C and D, proved the soundness of this theory and were decidedly superior to the binocular types in fieldlessness, but they inherited the disadvantages already described in connection with their prototypes (though the long-wave "collapse" of C, curiously enough, did not appear in H—a choke similar except that the outer part of the winding was reversed).

Where Screening Fails

The counterpart of type E—with equal sections—is, of course, impossible, because the outer sections are essentially unequal to the inner ones, and such construction is very liable to cause severe "acceptor" resonances. And the use of the iron core is impracticable, because it entirely upsets the action of the outer winding and makes it almost impossible to obtain anything like exact opposition of field. An air-core choke requires a very large number of turns of wire to make up for the inductance which would otherwise be lost in the opposition between inner and outer windings, and so the resistance becomes rather unreasonably high.

An obvious solution of the difficulty is to screen the choke. Like many obvious solutions, it is the wrong one. A typical example consists of a nine-section choke screened by an aluminium cover 1in. diameter × 2in. long. The sections are unequal, being smaller at the ends in the interests of low capacity, and there is an iron core. Any figure purporting to state the inductance is almost meaningless, because the cover exerts a reducing effect which depends very largely on the frequency, but it is of the same order as most of the others—0.15 henry. At high radio frequencies the screening is very imperfect. At medium audio frequencies—about 1,000 cycles—it is worse than imperfect. At 50 cycles it is almost negligible.

The screen is far from effective as a screen, but it is most effective in spoiling

HF Chokes—

the choke as a choke. Two series of tests were run on this specimen (distinguished as J and J[1]), the former with the screen "floating" and the other with it earthed, i.e., connected to the low-potential end of the winding. The results are shown in Fig. 5 and speak for themselves.

Still another expedient is available for avoiding coupling effects.

Instead of providing two similar coils side by side as in the binocular, where one may be nearer the source or recipient of the disturbance than the other, the two coils may be placed end to end. Any appreciable difference in the coupling to the two halves is then improbable, and an effective fieldlessness is obtained.

Effective Astatic Chokes

Choke K is an example of this construction, with eight equal sections; four wound in one direction and four in the other. The diameter over the outermost wire is about $\frac{13}{16}$in., and the total length of the wound portion $1\frac{3}{8}$in. The inductance is the usual 0.15 henry, and DC resistance 800 ohms—necessarily rather high, being

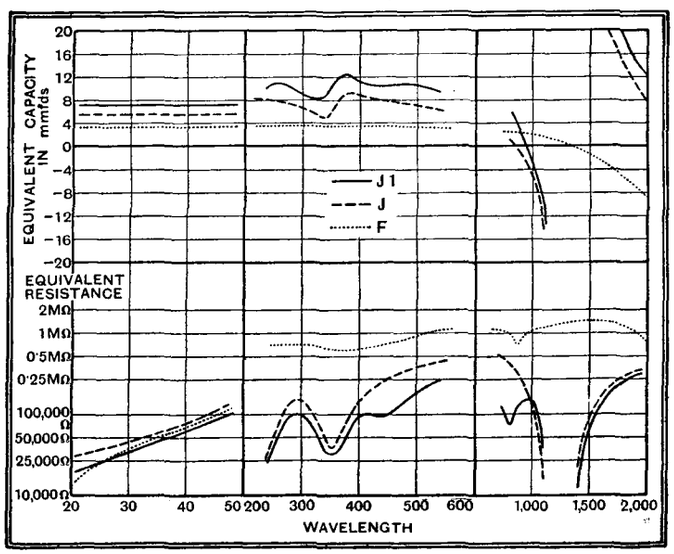


Fig. 5.—Performance curves relating to binocular and screened chokes.

an air-cored coil. Self-capacity averages 2 m-mfd., so the short-wave performance is very good, and on long waves it is quite exceptionally good. In fact, the only serious blemish is a hollow in the middle of the medium waveband, at 450 metres, where the effective resistance falls from about a megohm to 100,000 ohms.

The advantages of an iron core have already been pointed out—high inductance without too many turns, and consequently moderate DC resistance and low capacity.

Also, because the inductance falls as the frequency rises, it is possible for the one absorption hollow that seems to be the irreducible minimum, even with an equal-section winding, to be thrust down rather lower in wavelength than would otherwise be the case with a 0.15-henry choke. It is thus possible to put it into the "no man's land" between 100 and 200 metres.

A choke designed on these lines and called type L fulfilled expectations. There are eight sections, four in each direction, $\frac{7}{8}$in. diameter, and the two groups are separated by $\frac{5}{8}$in. and are each provided with an iron core. Owing to the small diameter and other precautions, the capacity is only 1 m-mfd., slightly more or less, and the effective resistance averages one megohm. Fig. 6 shows its record, and it will be noted that there are signs of absorption at about 200 metres. Over the whole of the normal broadcasting wavelengths both absorption and self-capacity are small and constant, so it is quite a competent choke even for the most exacting position of Fig. 1 (*b*). A negative capacity is, if anything, an advantage so long as it does not exceed about 10 m-mfd., for it helps to neutralise the stray capacity of the circuit, such as that of the valve.

Readers who have persisted up to this point are no doubt willing to concede that even such a simple component as a HF choke possesses unsuspected depths of character that require more than superficial acquaintance to comprehend.

The dissection and analysis of the foregoing examples will perhaps disclose some of the leading principles and enable a selection to be made for any particular requirement.

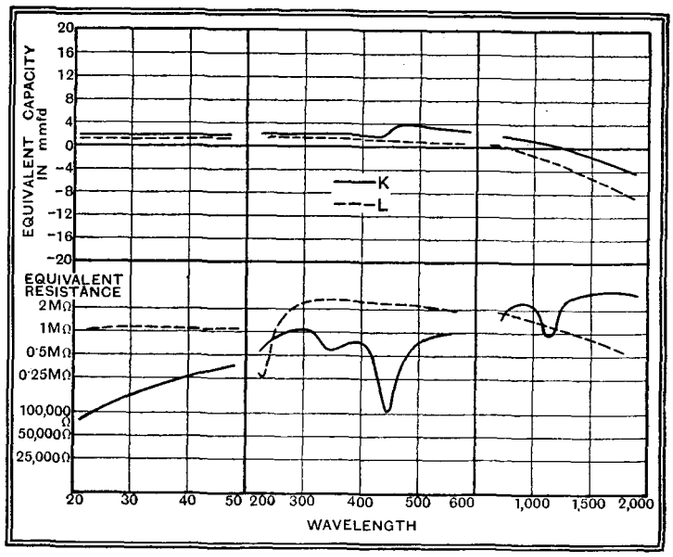


Fig. 6.—Astatic chokes: specimen K is of the fieldless type with end-to-end windings; L represents a very good design in which practically no absorption points are found on any broadcast waveband.

The Permeability Battery Four

(*See pages* 508-510)

THE LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Permeability Tuner, 4-gang	**Varley BP101**
2 Bulbs, 2-volt 0.06 amp. (for dial lights)	**Bulgin "E"**
2 HF Chokes, Ch1, Ch2	**Wearite HFPJ**
1 HF Choke, Ch3	**Bulgin HF8**
1 Rotary toggle switch, 4-point, **S2**	**Bulgin S116**
1 Rotary toggle switch, DPDT, **S1**	**Bulgin S114**
1 QPP Transformer, ratio 7:1	**Lissen LN5306**
3 Valve holders, 7-pin	**Belling-Lee 1138**
1 Valve holder, 5-pin	**Belling-Lee 1136/S**

(Clix)

1 Tapered volume control, 0.25 megohm, **R6** — **Ferranti "P"**
(Claude Lyons, Magnum, Rothermel)

Resistances (1 watt type):

1 2,000 ohms, **R2**	**Amplion**
2 10,000 ohms, **R1, R3**	
1 25,000 ohms, **R7**	
1 150,000 ohms, **R9**	
1 250,000 ohms, **R4**	
1 1 megohm, **R5**	
1 2 megohms, **R8**	

(Dubilier, Erie, Ferranti, Claude Lyons, Polar N.S.F., Watmel)

Condensers:

2 0.005 mfd., **C15, C16**	**Dubilier 670**
1 0.001 mfd., **C8**	**Dubilier 670**
6 0.0001 mfd., **C1, C4, C5, C9, C10, C12**	**Dubilier 665**
5 0.1 mfd. tubular, **C3, C6, C7, C11, C13**	**Dubilier 4503**
1 0.04 mfd. tubular, **C2**	**Dubilier 4503**
1 1 mfd. 500-volts D.C. test, **C14**	**Dubilier BB**

(Bulgin, Ferranti, Graham Farish, Polar N.S.F., T.C.C., T.M.C. Hydra)

1 Stand off Insulator (Raymart)	**Bulgin SW49**
1 Three-pin Plug and socket panel	**Belling-Lee 1119**
1 GB Battery, 16½ volts	**Siemens**
1 pr. GB Battery clips	**Bulgin No. 1**
4 Terminals, ebonite shrouded, A.E., pick-up (2)	**Belling-Lee "B"**
3 Wander plugs, GB+, GB−1, GB−2	**Clix "B"**
1 Battery cable, 5-way, 30in., with terminals and spade ends	**Belling-Lee**
1 Connector, 5-way	**Bryce**

6 lengths Systoflex, 2oz. No. 20 tinned copper wire, etc.

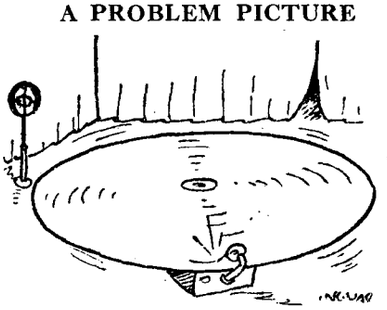
Screws: 30 6BA C/hd, $\frac{3}{8}$in.; 10 6BA C/hd, $\frac{1}{4}$in.; 5 4BA C/hd, $\frac{3}{8}$in., all with nuts.

Chassis No. 18 SWG aluminium, 14in. x 10in. x 2in. **Peto-Scott**

Valves: 2 Cossor 210 VPT; 1 Mullard TDD2A; 1 Marconi or Osram QP21.

Loud Speaker **Rola FR7/PM60**

A PROBLEM PICTURE



Appreciation of the technical aspects of record broadcasting was not needed by the cartoonist of the Danish journal *Politiken* to drive home his point that Copenhagen broadcasts too many gramophone records. The cartoon was headed: "The day's programme begins."

The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

	Page
Editorial Comment	531
The Permeability Battery Four	532
The Thyratron Inverter	535
Wireless and the Atmosphere—IV	538
Current Topics	541
High Fidelity Transmission over Lines	542
Broadcast Brevities	543
McMichael 135 AC Superhet Reviewed	544
Listeners' Guide for the Week	546
Foundations of Wireless—XXIII	548
Random Radiations	550
"Radio Romania"	551
Unbiased	552
New Apparatus Reviewed	553
Letters to the Editor	554

EDITORIAL COMMENT

Next Season's Sets

Changes We Hope to See

ALTHOUGH, during the past year or so, one or two set manufacturers have discontinued the idea of producing a complete range of new receivers at the time of the Olympia Show each year and instead bring out their new models irregularly, the majority still keep to the policy of a new series of sets at the commencement of the season. Manufacturers who adhere to this arrangement are at the present time busily engaged on the design of their new models, and it is certainly not too early to take the opportunity of reminding them of certain features which the public have been clamouring for in vain for a long time.

First and foremost, we must mention the question of tuning dials. One after another new models appear by manufacturers of high repute with little or no improvement as regards the visibility of tuning dials over earlier models, which, in all other respects, are now regarded as obsolete. Surely the time has come when really legible tuning dials, with station names clearly indicated, should be introduced by all set producers. Those who build their own receivers, too, are still in the position of having comparatively little choice available to them in the way of satisfactory dials.

External Loud Speakers

Next we would like to remind set manufacturers that, the time is coming when the public in their search for receivers with better quality reproduction will demand that their set should have the speaker as a separate unit from the receiver. It might surprise some manufacturers to know to what an extent the performance of their standard models can be improved by removing the speaker and mounting it with a separate baffle without any other change in the receiver design. We know that arguments can be put forward that packing, despatching, and the general handling of two separate units complicate marketing, but surely these considerations should not be allowed to override public demand.

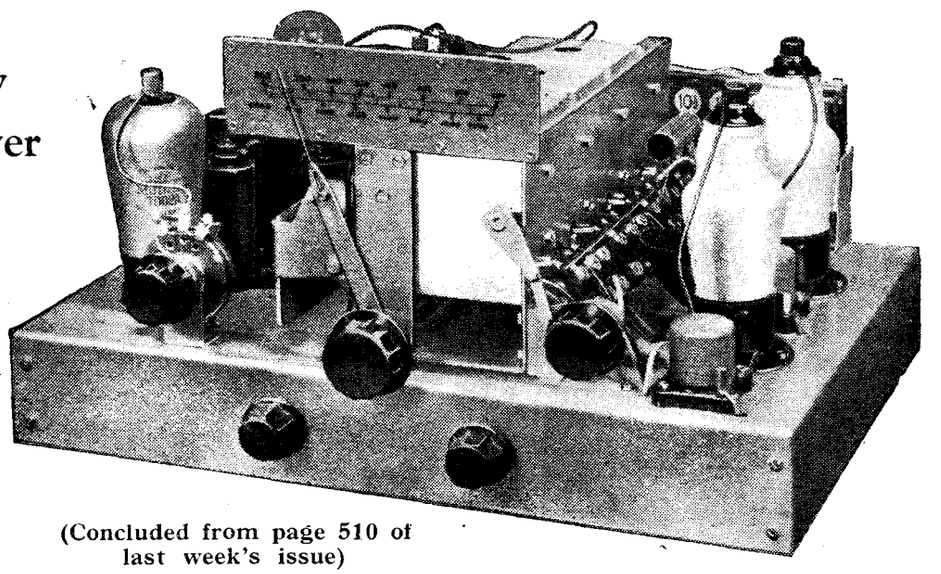
Help for the Set User

We have pointed out on many occasions that whereas it should be the aim of every manufacturer to take what precautions he can to ensure that his receivers will be used by the public under the best possible conditions, very little effort is at present being made to meet this requirement. Although the number of tuning controls has been reduced, tuning is, in some respects, rather more critical than formerly, when extreme selectivity was unnecessary. Every set should carry a summary of operating conditions in some permanent position in the set so that it is not likely to be removed from it. Whilst some manufacturers issue a comprehensive booklet on the operation of their sets, it is seldom that this remains for long in proximity to the set.

On the question of details of design there are many matters still requiring attention, but amongst the more important we would mention the need for fuses to be fitted to every mains receiver. If the house fuses alone are depended upon, these are often of too high a rating for adequate protection of the set, and it is the experience of those servicing receivers that far too frequently parts which are expensive to replace are damaged through neglect of this simple but necessary precaution. Fuses should be easily replaceable and, above all, should make positive and permanently good contacts.

The Permeability Battery Four

Constructing and Operating the New Long-distance Receiver

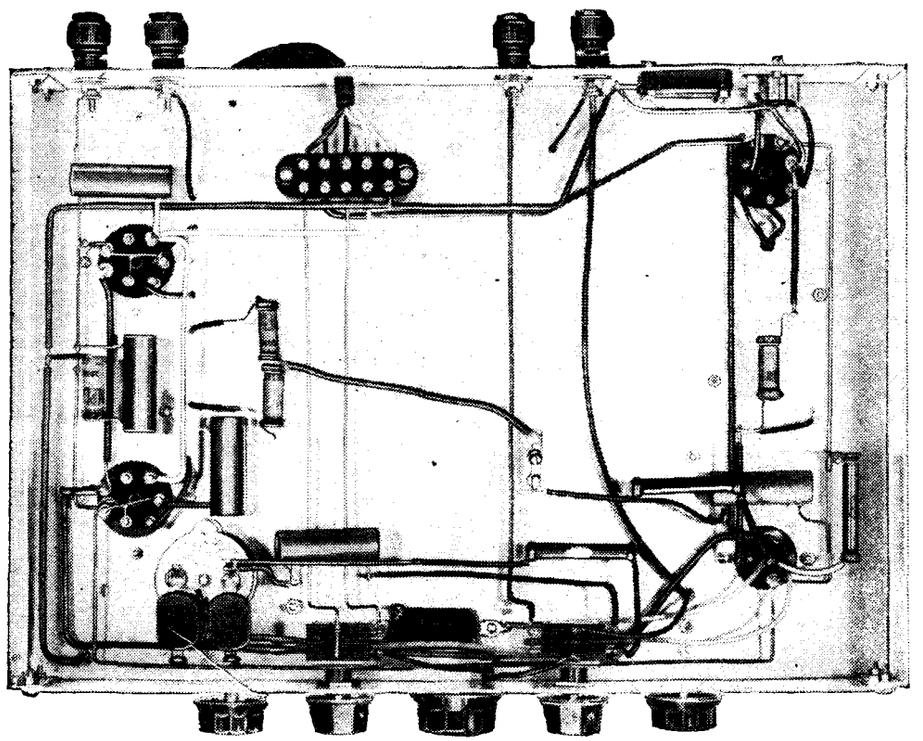


THE principles upon which this receiver operates were dealt with in detail in last week's issue, and in this article the construction and operation are considered. A metal chassis is employed and the layout of components is such that the assembly and wiring are exceptionally straightforward.

(Concluded from page 510 of last week's issue)

THE theoretical considerations underlying the design of the new receiver were fully described in last week's issue of *The Wireless World*, and it only remains to deal with the construction and operation. The components are all assembled on a metal chassis, which can be obtained ready drilled, and the layout adopted is such that it gives a maximum of isolation to the different circuits without calling for the erection of screens, while in most cases the leads are short and direct. Care should be taken to see that the bolts holding down components such as the tuner and HF chokes, which rely on their contact with the chassis for earthing their screens, are thoroughly tightened. When mounting the components the tuner should be left to the last, partly because it is the weightiest part, but chiefly because its absence renders the fixing screws of several small components more accessible.

The wiring is carried out with tinned copper wire run in insulating sleeving where necessary. No. 18 wire is used in most places for rigidity, and it may be remarked that the wire is best straightened by stretching it slightly. Care should be taken to carry out the wiring as far as possible in the manner adopted in the original receiver and clearly shown in the drawings and photographs which accompany this article, and by this is meant not only that the same points in the set should be joined together, but that the connecting leads should lie in the same relative positions. The failure to observe points of this nature may quite possibly result in instability, for it is all too easy to couple different circuits together by running the wiring so that large loops are formed.



This underbase view of the receiver clearly shows the simplicity of the wiring.

The Batteries

The set is intended to operate with a total HT supply of 120 volts, and some 60 to 70 volts should then be applied to the screen grids. A bias of -1.5 volts is sufficient for the triode section of the TDD2A valve, but the QP21 should have about -9 volts applied to it. The bias which best suits the particular valve employed should be found experimentally; in most cases it will be about -9 volts, but in a few -7.5 volts may lead to better quality, and in others -10.5 volts will prove more suitable. The higher the bias employed the lower will be the current consumption, but excessive bias will cause severe distortion. If a milliammeter be available and be connected in series with the lead to the centre-tap of the output transformer primary, the bias should be so chosen that a current of about 2.5 mA. is obtained when no signal is applied. The application of a signal will, of course, cause the current to jump to values which are many times this figure, according to

The Permeability Battery Four—

the depth of the modulation, in common with all quiescent types of output stage.

The use of a higher anode voltage will, of course, enable somewhat larger volume to be obtained before distortion sets in, and up to 150 volts may be used, but the grid bias will have to be increased somewhat. A voltage greater than 120 should, strictly speaking, be applied only to the LF and output stages, for if it be used also on the HF stages the increased stage gain may result in instability. This can be cured by using a somewhat lower screen voltage, but it is advisable to adhere to the recommended condition of 120 volts anode potential for the HF stages.

The only adjustments necessary to the receiver are to the ganging, and this must first be carried out on the medium waveband, for which the waveband switch must be rotated in an anti-clockwise direction. There are two trimmers for each tuned circuit arranged concentrically on the tops of the screening cans; the medium-wave trimmers are adjusted by means of a narrow-bladed screwdriver, and it must be remembered that with these the capacity is increased by an *anti-clockwise* rotation. The long-wave trimmers are adjusted by a hexagon nut for which a spanner is supplied with the tuner, and here a *clockwise* rotation increases the capacity.

Tune in the weakest medium-wave station which can be found, and adjust each of the four appropriate trimmers for maximum signal strength. Unless the station be very weak, it may be difficult to judge the optimum settings accurately by ear owing to the action of AVC. Some form of tuning indicator is advisable, therefore, and in its simplest form this can consist of a low-range milliammeter connected in series with the HT lead for the screen grids; it is quite satisfactory to interpose it between the wander-plug and the tapping on the battery, and, of course, the positive terminal of the meter should be taken to the battery. With no signal a reading of some 2.5 mA. will be found and this will decrease on tuning in a signal which is strong enough to actuate AVC. The greater the strength of the signal the lower will be the current, so that, when a meter is used, instructions to trim for maximum signal strength must be interpreted as trimming for the minimum current indicated by the tuning meter.

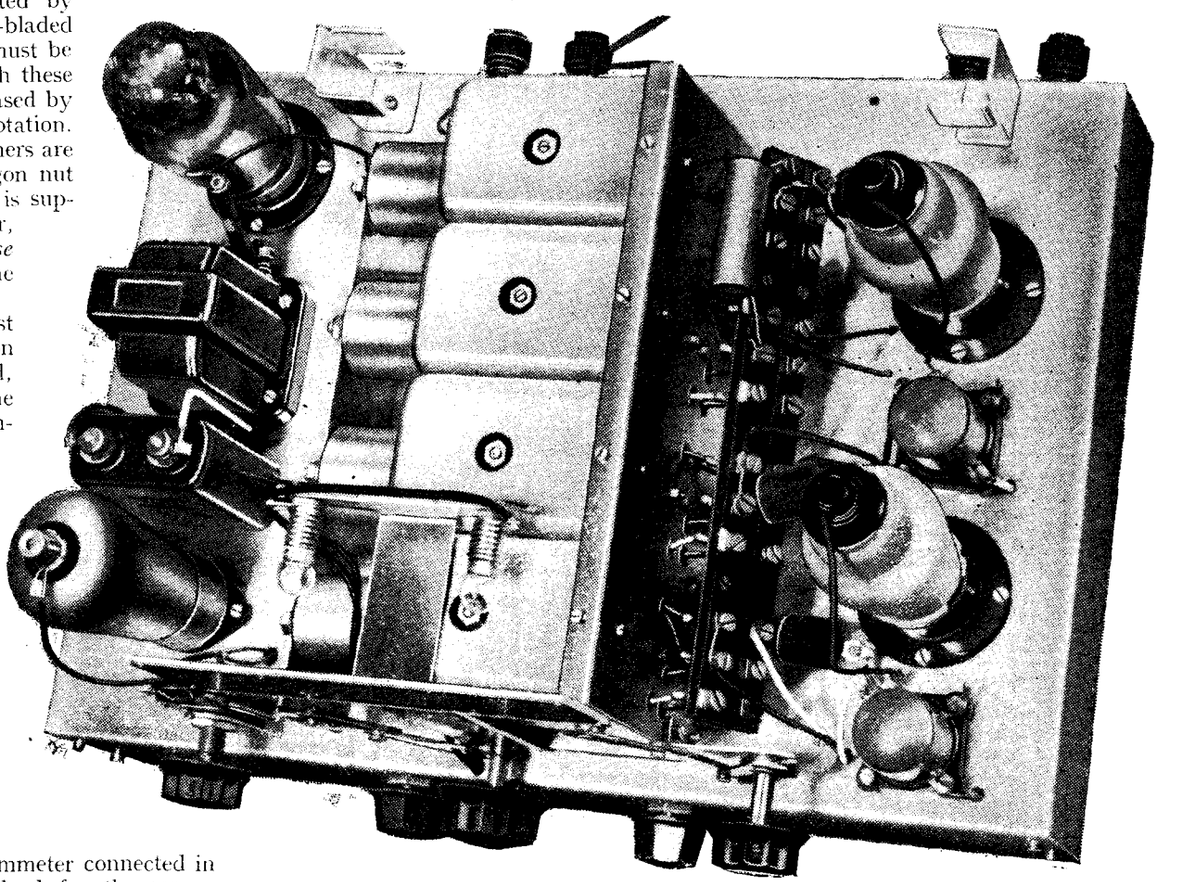
Having trimmed the circuit approximately, a station on a wavelength of some 250-300 metres should be found and the circuits re-trimmed carefully at this point. In general, the last circuit should be trimmed first and the others in order working towards the aerial; this means that the section of the tuner nearest the panel is the first to receive attention and the one at the back the last. It may be remarked that the adjusting screws are all at earth potential to HF currents except that on the front section. Here it is necessary to use an insulated screwdriver, for violent instability during the adjustment may occur if an all-metal tool be used.

Ganging

When all the circuits have been adjusted in the manner just described, it should be found that the ganging holds well over the whole of the medium waveband, but unless the correct capacity has been used in the trimmers the wavelength calibration marked on the tuning scale may not hold good. If this be found to be seriously out, the simplest method of correcting it is to choose a fairly strong station of known wavelength towards the middle of the waveband. Set the tuning dial so that its reading corresponds with the wavelength of the station selected, and then proceed to tune it in by means of the trimmers, using these as the controls of an unganged receiver. Adjust each trimmer exactly for maximum signal strength, and it should then be found that not only is the ganging accurate but that the wavelength calibration holds reasonably well.

When satisfied with the performance on the medium waveband, the long waveband can receive attention. It is as well to leave this to the last, for any alteration to the medium-wave trimmers affects the long-wave ganging, whereas the converse is not true. The trimming should first be roughly adjusted on Droitwich, and accurately on Huizen, if this station can be found. The procedure is exactly the same as on the medium waveband, save, of course, that the hexagon nuts must be employed instead of the screws. In order that difficulty in trimming the front section of the tuner may be avoided, it is as well to fit the spanner with an insulating handle, and, of course, it must not be permitted to touch the screening, although an accidental short-circuit to the can will cause no damage.

On operating the receiver it will be found that the selectivity at the high wavelength end of the medium waveband is somewhat below that obtained with the same number of tuned circuits using condenser tuning, but that at the other end of the range it is greater. Towards the middle of the band the selectivity is of the same order. This, of course, is to be expected, since the circuits give about the same *average* selectivity as the ordinary type, but it does not vary over the waveband to anything like the same degree.

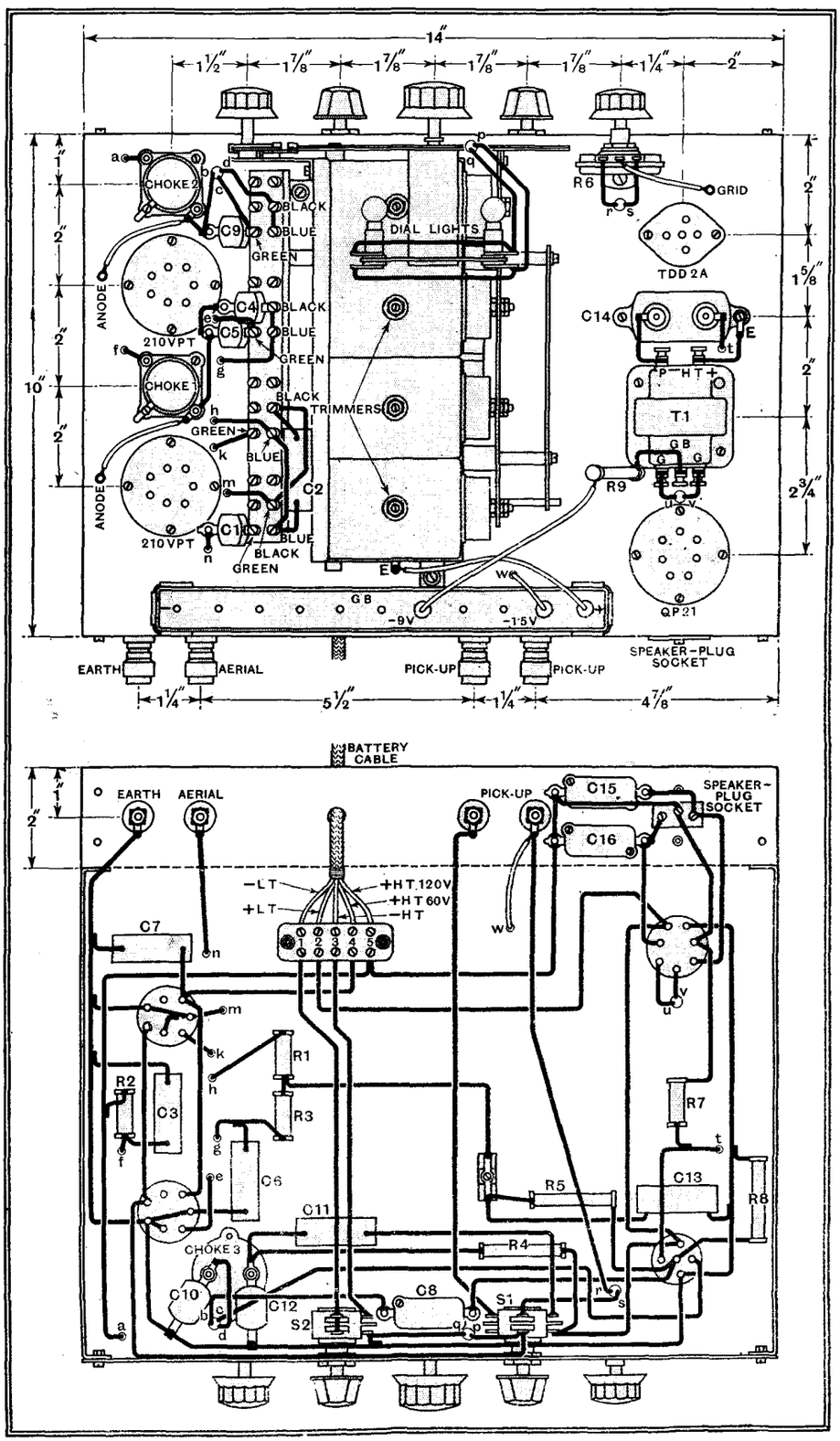


A bird's-eye view of the chassis in which the chief parts clearly stand out. The space to the left of the tuner is devoted to the LF equipment.

The Permeability Battery Four—

The selectivity on the long waveband is somewhat greater than on the medium, for the same ratio of inductance to resistance is not maintained in the tuner. This meets the requirements of this congested waveband, and the poorer high-frequency response which necessarily results is unimportant in view of the generally lower standard of transmission on these wavelengths. The statement that the set is more selective on the long waveband than on the medium should not be misunderstood, for although the real selectivity is higher, the apparent selectivity is lower! Selectivity is all too often judged by the flatness or sharpness of tuning, whereas this has actually nothing whatever to do with selectivity. Any set can be made to tune as flatly or sharply as we like simply by choosing a suitable ratio drive in the dial or a suitable ratio of maximum to minimum wavelength for the range, or both. The apparent selectivity only depends on the number of kilocycles change in frequency for a given movement of the pointer over the dial, and this is much smaller on the long waves than on the medium.

A full-size blue print of the wiring diagram is available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d. post free



Full constructional and wiring details of the receiver are shown in these drawings.

The sensitivity is adequate for all normal requirements and the set will give reliable daylight reception of a number of Continental transmissions, while after dark most worth-while stations can be well received. The selectivity is adequate for the degree of sensitivity provided, and in London it is by no means difficult to receive Cologne clear of North Regional on the adjacent channel, although in daylight it is considerably the weaker signal. On the long waveband the Deutschlandsender can be heard while Droitwich and Radio Paris are working, but cannot be received free from interference. Both these transmissions are, of course, much stronger than the German station. The quality of reproduction is of a high order, particularly so, indeed, in view of the low total current consumption, and it is satisfying even for local reception, for which one subconsciously demands a higher standard than for distant stations.

The AVC system has a wide range of control. It comes into operation on fairly weak signals so affording good compensation for fading, and overloading is unlikely even on local stations. No local-distance switch has been fitted, therefore, since tests have proved it to be unnecessary in ninety-nine cases out of a hundred. Where the set is used at a very short distance from a transmitter, of course, such a fitting may prove advisable to avoid distortion when listening to the local, and it is suggested that it would best take the form of a make-and-break switch connected to throw a resistance across the aerial and earth terminals. The value of resistance required will naturally vary according to circumstances, but a value of some 100 ohms to 500 ohms will meet most requirements.

It should be noted that the tapered volume control R6 is a Ferranti type "PG," not "P," as given in the list of parts published last week.

THE RADIO INDUSTRY

THE fourth edition of a booklet entitled "Practical Hints on Patents," which deals in simple language with the subject of patent protection and the procedure involved in obtaining it, has just been issued by The Imperial Patent Service, First Avenue House, High Holborn, London, W.C.1.

Halcyon receivers Types AC/7 and AC/7G, which were recently introduced, are described and illustrated in a leaflet obtainable from Halcyon Radio, Ltd., Sterling Works, Dagenham, Essex.

Change of address: The Redcliffe Radio Mfg. Co., to 69, Victoria Street, Bristol 1. Telephone: 22166.

The Pye Cambridge receiver, Model CR/AC, now costs 15 guineas, complete with stand.

THE Thyratron Inverter

How to Build a DC-to-AC Converter

By F. BUTLER, B.Sc.

THE author describes the construction of a purely static device, without any moving parts, for converting DC current to AC for operating receivers, amplifiers, or other purposes. By choosing thyratron valves and a power transformer of appropriate types, AC outputs of either 100 or 400 watts may be obtained.

THE process of rectification of alternating current is now well understood, and apparatus of any desired output capacity is available. With regard to the opposite process, methods of converting DC power into AC have been devised using motor-alternators, arc generators, vibrating reeds in conjunction with induction coils, and, more recently, gas triodes or thyratron tubes. The properties of the last-named are used in the inverter here described, which is designed for a full-load output of 100 or 400 watts according to the tubes employed. The apparatus is entirely static, and shows advantages of high efficiency and low initial cost.

A previous article[1] has outlined some of the most important features of these tubes, which are essentially triodes containing a small quantity of residual gas, generally argon or mercury vapour. In operation, the electrons passing from cathode to anode ionise the atoms of residual gas and form other ions by collision. The positive ions fall slowly on to the cathode, neutralising the negative space-charge near it. This space-charge accounts for the high internal resistance of hard valves and involves the dissipation of large amounts of energy if an attempt is made to pass a large space current. This energy appears as heat at the anode, and limits the power-handling capacity of the valve.

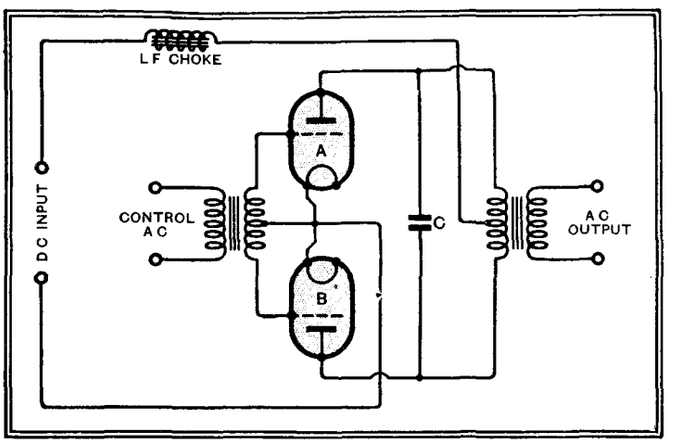


Fig. 1.—Illustrating the principles of operation of the thyratron inverter.

The voltage drop across the thyratron tube is reduced by the positive ion sheath to about 20 volts, so that for a given anode dissipation large currents may be passed. Several other special characteristics follow as a consequence of the residual gas filling. The chief of these are that the voltage drop between anode and cathode must not exceed 15 to 22 volts, and the filament or heater voltage must be low (usually 5 volts or less) in order to avoid cathode disintegration by positive ion bombardment. Most important is the modification of the control action of the grid. If this is maintained negative no anode current passes until the voltage reaches a critical value. Then a discharge passes, which is limited only by the external circuit resistance. The grid ceases to exercise further control owing to the formation round it of a positive ion sheath, and current can only be stopped by switching, or by temporarily reducing the anode voltage to a value in the neighbourhood of 15 volts. This may be done by switching a condenser across anode to filament, after which, if the grid is sufficiently negative, the discharge will not start again. The ratio of anode voltage to the negative grid voltage which will just prevent the flow of space current is known as the control ratio of the tube, and corresponds to the amplification factor of a hard valve.

Work on gas-filled tubes has led to the production of valves capable of passing space currents of the order of the ampere. By passing this current through the primary of a transformer, and interrupting or reversing it, an AC output is obtained. In practice, this operation is best performed by two tubes. The circuit of Fig. 1 shows what appears to be a conventional push-pull amplifier, with the addition of a condenser joining the anodes of the valves. An input AC is applied to the grid transformer. Suppose the grid of tube A swings positive, while B swings negative by the same amount. The first tube passes anode current from the supply, which cannot subsequently be stopped by the control grid. At the end of a half-cycle of the AC the grid of B becomes positive, and that of A negative, while the action of the output transformer has charged up the condenser C during the time the valve A passed current. Immediately tube B commences to conduct, the charge on this condenser has the effect of driving the anode of A negative, which stops its discharge. This does not start again, as the grid is now negative, and remains so until the next cycle commences. The action is repeated, and each pulse of current through the half-primary of the output transformer behaves like a half-cycle of an ordinary AC supply. The choke coil shown serves to improve the commutation of current from valve to valve.

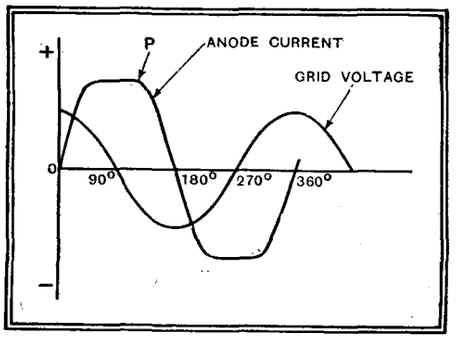


Fig. 2.—Phase relationship between grid voltage and anode current in a self-exciting inverter.

Automatic Grid Control

The objection to the simple inverter shown is the need for a control AC, and means have been devised for effecting the commutation by utilising the output AC. The method may be seen from the curves shown in Fig. 2, which represents one complete cycle. For the first quarter-period the grid voltage is shown positive, and the associated tube passes current as shown. At the point P, the grid of the second tube has swung sufficiently positive to trigger the discharge, and the action of the anode condenser stops the current through the first tube, which does not fire again until the grid becomes sufficiently positive. To effect the desired commutation of current, the grid voltage must lead the anode current, which suggests the further point that in the use of this form of inverter on an inductive

[1] "The Thyratron," by F. E. Henderson, A.M.I.E.E., *The Wireless World*, January 13th, 1932, p. 29.

The Thyratron Inverter—

load commutation will be difficult. A lagging power factor may be corrected by the use of condensers across the load. Those familiar with AC working will see that, to obtain the phase relations between anode current and grid voltage shown on the graphs, it is sufficient to design a phase-correcting network to give a lead of approximately 90°.

Fig. 3 gives the full circuit diagram, with values of components. Many of them are standard radio products, but the four-pole change-over switch S, the power resistances R1 and R2, the main choke No. 1, and the transformer T1 may not readily be obtainable. The function of the switch is to run the valve heaters from the mains through the voltage-dropping resistance R1 until the cathodes are sufficiently heated for operation to commence. In the running position, this resistance is cut out and the heaters worked from a winding marked XX on the main transformer. During preliminary adjustments it is best to run them from a car battery, tapping off the voltage required.

The values of the resistances R1, R2 depend on the heater voltage and current of the tubes, and on the maximum permissible anode current. The requirements of the recommended tubes are indicated in the table. The heater of the BT5 requires 5 volts 4.5 amperes, or for the two in series, 10 volts 4.5 amperes. The smaller tubes, MR/AC1 and GT1, each require 4 volts 1 ampere, or in series, 8 volts 1 ampere. The resistances required may be calculated by subtracting the total filament voltage from the mains voltage and dividing by the heater current. For the BT5, assuming 250-volt mains, the required resistance is $(250-10)\div 4.5$, or almost 53 ohms. This resistance might be made from a 1-kW 250-volt heating element or fire bar, the wire being cautiously unwound until, on test, a current of 4.5 amperes is passed.

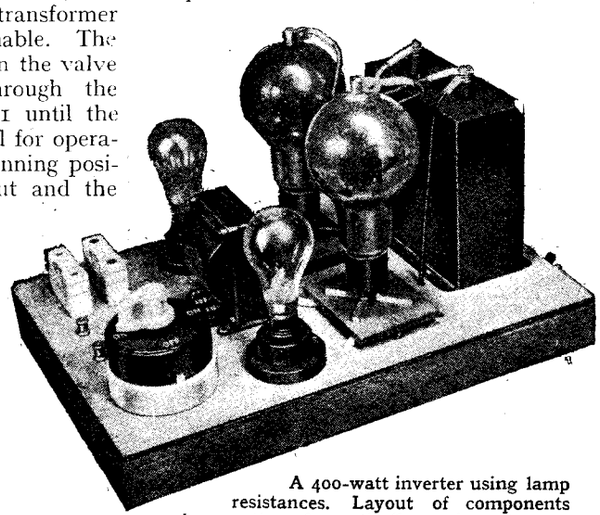
If the smaller tubes are used, the resistance is $(250-8)\div 1$, or 242 ohms. A bank of lamps totalling 240 watts could be employed here, the exact current being measured and adjusted to the correct figure by trying lamps of different rating. The value of the resistance R2 is not critical, and may be 60 ohms maximum for the BT5 or 400 ohms for the GT1 or MR/AC1.

The resistance can be used, if desired,

CHARACTERISTICS OF THYRATRON VALVES.

	B.T.H. BT5.	Osram GT1. Ediswan MR/AC1.
Heater volts ...	5 volts	4 volts
Heater current ...	4.5 amps.	1.0 amp.
Anode Current :		
Peak	12.5 amps.	0.6 amp.
Mean	2.5 amps.	0.3 amp.
Anode voltage (peak reverse) ...	1,000 volts	1,000 volts
Type of base ...	American 4-pin (one side of heater connected to cathode).	Standard 5-pin (connections as for indirectly heated AC triode).

to give a control over the output voltage, but must then be capable of carrying continuously the full-load anode current. The switch S may conveniently consist of two double-pole change-over switches connected by a coupling bar. The chokes Nos. 2 and 3 are connected as close to the anodes as possible, and serve to keep radio frequency disturbances from the output side. They consist of a few hundred turns of wire heavy enough to carry the anode current, and may be wound on tubular formers, or in the form of taped slab coils. Two similar chokes may be placed in the DC lines, and when these



A 400-watt inverter using lamp resistances. Layout of components is a matter of practically no importance.

precautions are taken it is possible to operate a sensitive receiver from the output, or from the DC mains, with no interference except that radiated direct from the apparatus. This can be completely suppressed by screening the whole apparatus or by placing it in a metal box. Readers may be reminded that a good earth minimises the risk of

SPECIFICATIONS FOR POWER TRANSFORMERS.

Windings Required.	400 Watts.	100 Watts.
Centre-tapped Primary. (DC input side) ...	Volts. 160—0—160	Volts. 160—0—160
Output Secondary. Tappings every 10 volts between 200 and 260 volts ...	260	260
Heater Secondary. Tappings	14 volts 4.5 amps. 10, 11, 12, 13, 14 volts.	10 volts1 amp. 6, 7, 8, 9, 10 volts.
Rating of transformer (continuous)	0.4 kVA.	0.1 kVA.

any interference, which in this case is almost entirely confined to the long wave-band. The anode chokes also serve to prevent cathode disintegration by the heavy instantaneous currents resulting from the discharge of the anode condenser when each tube fires. This is a well-known cause of premature failure of thyratron tubes.

Considering first the higher power apparatus, the essential requirement of the choke No. 1 is that it should maintain adequate inductance when carrying currents up to about 2 amperes. The core may consist of Stalloy stampings Type No. 35, core section 1½in. × 3in., assembled so as to leave a 2-millimetre air-gap. The coil is section-wound with 5 lb. of No. 18 DCC copper wire, which is run through a bath of insulating varnish before winding. The coils should be well taped, baked and insulated from the core.

One of the many firms specialising in such work would be able to supply a choke of this type and also a suitable mains transformer. The latter works under the same conditions as a full-wave rectifier transformer, and may be designed as for ordinary AC work to comply with the specification given above, assuming a 250-volt DC supply to the inverter. The

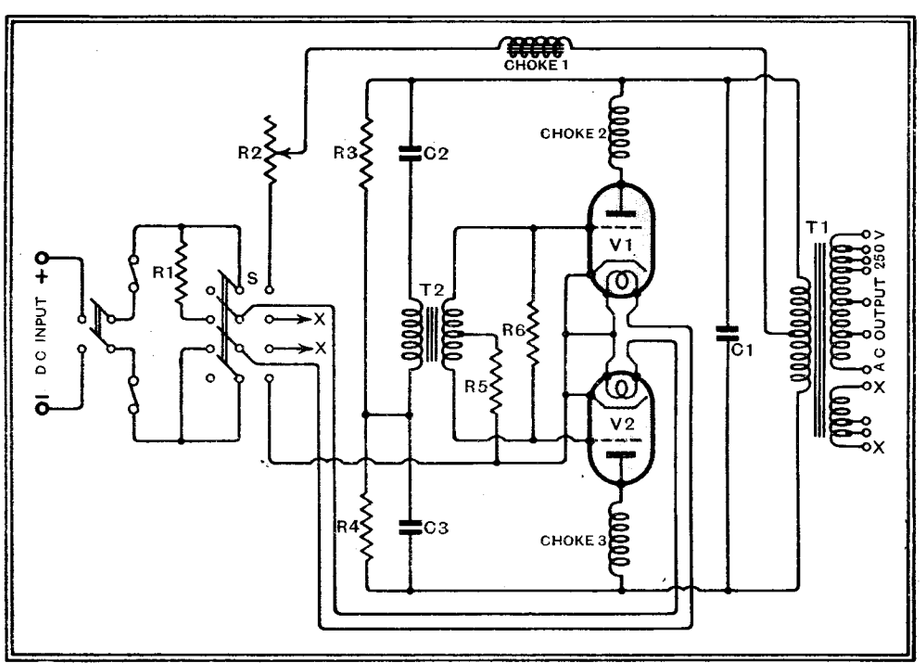


Fig. 3.—Complete circuit diagram of the inverter. R1, R2, see text ; R3, R4, 5,000 ohms, 20 watts ; R5, 5,000 ohms, 5 watts ; R6, 10,000 ohms, 5 watts ; C1, 4 mfd. ; C2, C3, 1 mfd. (all 1,500 volts working) ; V1, V2, thyratron tubes.

The Thyratron Inverter—

primary input voltage across each half-section of the winding for any DC voltage is given approximately by (mains voltage – 20 volts) ÷ $\sqrt{2}$. In the case of 250-volt mains this gives 160 volts as the input required.

The grid transformer T2 may be made or obtained finished. Any push-pull driver or output transformer will serve, provided it gives a step-down ratio (overall) of about 2 : 1. Actually a Ferranti OPM1c is employed in the apparatus described.

Lamps as Resistances

To raise the efficiency, particularly with the smaller inverter, the resistances R3, R4 may be increased to 10,000 ohms, but with greater risk of the tubes failing to start their action. If desired they may take the form of metal-filament lamps, and little difference in performance is shown when sizes between 30 watts and 5 watts are used. Voltage rise on low loads may cause early failure of the lamps if very low-consumption bulbs are used.

It is most important that the cathodes should be really hot before the apparatus is used. A resistance must be used in series with the main choke when starting to limit the current to the safe value for the tube in use. The procedure is then as follows: With the switch in the starting position, allow the heaters fifteen

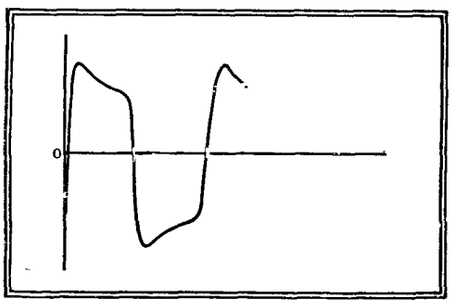
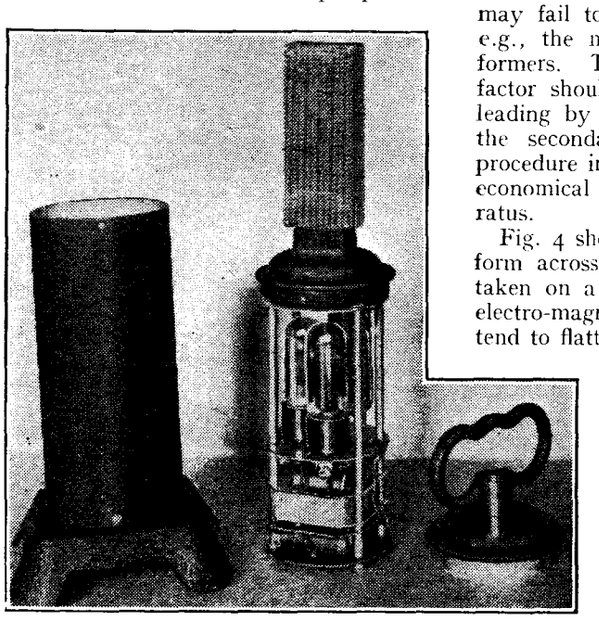


Fig. 4.—The voltage waveform of the output of a thyratron inverter.

minutes to attain the correct temperature. With the anode resistance at its maximum value, throw over the switch to the running position. A flickering blue glow should appear in the tube. If this is present all is correct, and the anode resistance should be rapidly adjusted until an ammeter placed in the filament circuit indicates 4.5. If the flicker does not appear, switch off at once. Reverse the leads to the grid transformer primary, heat up the tubes and try again. The action will now commence if the rest of the circuit is in order. During early tests it is safer to heat the filaments from batteries unless the actual transformer output is known. When satisfactory operation on no-load is secured a test may be made with various loads. Two important points must be observed. When starting on low-resistance loads, such as metal-filament lamps, whose cold resistance is about one-fourteenth of that when hot, the peak emission from the cathodes must be greater than the initial current. The cathodes must therefore be kept up to the correct operating temperature by adjustment of R2 or by the use of a filament rheostat. In the second case, the tubes may fail to start on an inductive load, e.g., the magnetising current of transformers. To avoid this the load power factor should always be made unity or leading by the use of condensers across the secondary output terminals. This procedure incidentally results in the most economical operation of any AC apparatus.

Fig. 4 shows the output voltage waveform across a 400-ohm resistance load taken on a Cambridge Instrument Co.'s electro-magnetic oscillograph. The peaks tend to flatten out as the load increases.



A COMPACT PRE-AMPLIFIER.

Designed for use with the Rothermel-Brush G-4S6P piezo-electric microphone, this two-stage amplifier may be adapted for suspension with the microphone or as a pedestal base.

New Marconi and Osram Valves

Triode-Hexode and Duo-Diode

INTERESTING new valves are announced by Marconi and Osram. The first of these is the X41 triode-hexode, which is the combination of a hexode and a triode in a single glass envelope and is intended to function as a frequency-changer in a superheterodyne. A common cathode is used, and the heater consumes 1.2 amperes at 4 volts. The triode section of the valve functions as an oscillator with the tuned circuit in the grid circuit of the valve. A grid leak of some 50,000 ohms returned to the cathode should be used for biasing purposes, and with this a grid condenser of 0.0001 mfd. is suitable. The anode supply should be obtained from the HT supply through a dropping resistance of some 30,000 ohms. The optimum operating conditions are secured when the oscillator voltage is about 25 volts peak, and this is most readily determined by checking the grid current. A milliammeter inserted in series with the grid leak should show a current of some 0.4 mA.

The X41 triode-hexode

The hexode section of the valve consists of a control grid which surrounds the cathode, two screen grids, between which a coupling grid is inserted, and an anode. The coupling grid is connected internally to the triode grid, and so has applied to it the full oscillator voltage. The anode is rated for some 200-250 volts, with 70 volts on the screen grids and −1.5 volts grid bias on the control grid, and under these conditions a conversion conductance of 0.55 mA/V. is obtained, while the AC resistance is as high as 2 megohms. The valve is fitted with a 7-pin base, to which the connections are the same as in the case of the more familiar heptode.

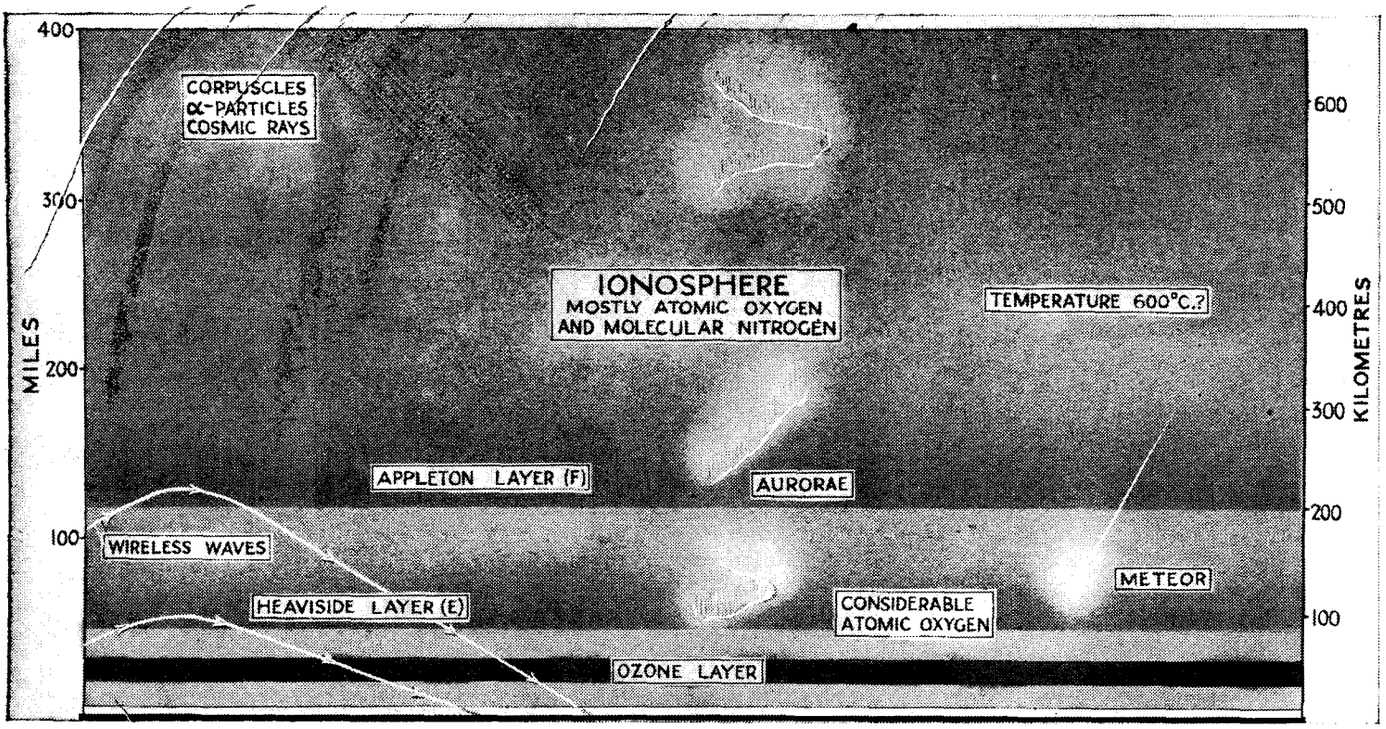
Short-wave Reception

The valve possesses several advantages over the heptode. In the first place, although the conversion conductance is of the same order, the AC resistance is higher, and so the first IF circuit is more lightly damped, thus making for higher selectivity. Secondly, the mutual conductance of the oscillator section is higher, with the result that reliable oscillation can be secured even at wavelengths as low as 4 metres, where a single heptode usually fails. Thirdly, unwanted couplings between the two sections are greatly reduced, so that there is much less interaction between the signal and oscillator frequency circuits, and this is very important in short-wave reception.

This new valve is listed at 20s., and it is understood that a universal model with a heater rated for 13 volts at 0.3 ampere will shortly be available at the same price and under the type number of X31.

The second of the new valves is a duo-diode, the D41, which can be used either in ordinary AC sets or in universal receivers, since its heater consumes 0.3 ampere at 4 volts. It is advised that the diode load resistance should not be less than 0.25 megohm, and that the peak HF input should not be greater than some 40 volts. The valve is fitted with a 5-pin base and is priced at 5s. 6d.

Wireless and the Atmosphere



IV.—The Ionosphere, the Home of the Heaviside and the Appleton Layers

By R. T. BEATTY, M.A., B.E., D.Sc.

ABOVE the ozone layer lies the vast territory of the ionosphere where such visitors from the sun as corpuscles and α-particles are captured. It is lit by the streamers of the polar aurora, whose spectrum tells us of the constitution of the air at these heights. Here are the Heaviside and Appleton layers, and possibly others as well, which reflect wireless waves and make long-distance communication possible.

THE region which lies above the ozone layer is one which as yet has been imperfectly charted, so that it is impossible to draw accurate maps of the pressure, temperature and composition of the upper atmosphere.

Some information comes from the aurora, whose height has been measured over many years by the use of theodolites at stations spaced far apart. The heights vary from 80 to 600 kilometres, or higher, and at all heights the auroral spectrum shows lines due to atomic oxygen and molecular nitrogen. No lines of hydrogen and helium have been seen, and it is believed that these light gases, which we might expect to accumulate in high regions, have long ago disappeared into space. If this is so the high regions must have a temperature of about 600 deg. C. to give these gases enough energy of motion to escape against the gravitational pull of the earth.

But these things, though of interest to the meteorologist, are not of such great importance to the radio worker as is the state of electrification at high levels, and it is fitting that it is by the behaviour of wireless waves that this information has been obtained.

We are apt to take for granted the existence of the Heaviside and Appleton layers, but the enquiring mind must ask why electrification should exist, and why it should be concentrated in layers instead of being spread all over the upper sky, why these layers rise and fall, and why they reflect wireless waves down to earth.

Causes of Electrification

We know from experiments in the laboratory that when ultra-violet light falls on oxygen or nitrogen it ejects electrons from the atoms or molecules, thus leaving positively electrified ions while the negative electrons wander about till they are captured by ions. As shown in Fig. 1, it is only very short waves of light which can ionise air, waves which never reach earth since they are absorbed at high levels. Here, then, we have a reason for expecting ionisation in the upper air, and probably other ionising agents are also at work, such as cosmic rays, meteors, and corpuscles of high velocity ejected from the sun.

We next ask why this electrification is not continuous throughout the atmosphere instead of being found in a series of stratified layers. To this question a simple answer can be given: Take, for example, the waveband which ionises the oxygen molecule, a band which, from Fig. 1, is seen to begin at 100$\mu\mu$. Now, when this radiation first enters the atmosphere it suffers little absorption because the air is very thin. But, as shown in Fig. 2, the air pressure increases rapidly, and consequently the rays are more and more quickly absorbed till at 40 miles up absorption is complete and ionisation ceases. Hence, ionisation is negligible at 120 miles and at 40 miles, and so it must rise to a maximum somewhere in between. In fact, the ionisation is proportional both to the intensity of the rays and to the density of the gas, and so by multiplying together at any point the heights of the two curves we can trace the dotted curve, which represents a layer well defined on the right-hand side.

Fig. 2 is merely descriptive. Accurate

Wireless and the Atmosphere—

curves cannot be given in our present state of ignorance of the composition of the atmosphere at high levels. But on any reasonable assumptions the ionised layer will always show fairly well-marked boundaries, and any constituent of air which is ionised by solar radiation will give rise to such a layer.

What are these constituents at heights above 50 miles? We have direct evidence from the spectral lines of the polar auroras, which tell us that oxygen and nitrogen are present at all heights. Hydrogen and helium do not appear, and, as we have said, there are reasons for believing that they have escaped into space. Hence O, O_2, N, N_2 probably form the chief constituents at high levels. Each of these may form a distinct ionised layer, and some day we may know enough to draw Fig. 2 accurately for each of these gases.

Actually, there are two permanent layers, the Heaviside at 60 miles and the Appleton at 120 miles, but it is of great interest that Appleton has found in addition two intermediate layers which appear and disappear capriciously, and it may be that these four layers correspond to ionisation of O, O_2, N, N_2. But this is merely

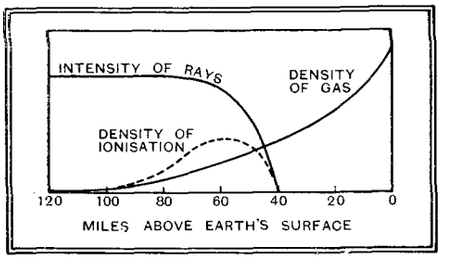


Fig. 2.—Light is absorbed as it travels through increasingly dense air on its way to earth and any ionisation produced is concentrated in a layer.

If a glass were discovered with n smaller than unity, then light would travel more quickly in it than in air, and the rays would be bent downwards.

All this is true also for wireless waves which differ from light only in having a greater wavelength. But for wireless waves we can measure n by a totally different method, for Clark Maxwell showed that the refractive index of any material is connected with the quantity K, called the dielectric constant by the relation $n = \sqrt{K}$.

The dielectric constant K is defined as follows: Take an air condenser, as in Fig. 4, and measure its capacity; then fill the air space with, say, a block of ebonite, and measure the capacity again. Then the ratio of the new capacity to the old is K, the dielectric constant of ebonite. In an insulator whose power losses are negligible the current leads the e.m.f. by 90 deg., and on entering such a medium wireless waves would bend upwards, as in Fig. 3 (b), and would travel on without any attenuation.

But what we require is a medium which bends the waves down, as in the Heaviside layer. How are we to obtain this effect?

Think of a single atom in the insulator of Fig. 4, and draw it as in Fig. 5 (a), where the atom is shown as a massive

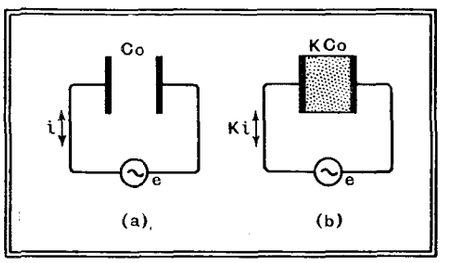


Fig. 4.—An ebonite condenser has a bigger capacity than an air condenser of equal size.

block with an electron attached by a spring. As the horizontal electric force applied from the condenser plates oscillates the electron will be set into forced vibration along the horizontal. As we know, the electrical equivalent of a mass and a spring is an inductance in series with a capacity, the inductance representing the mass of the electron and the capacity the compliance (lack of stiffness) of the spring, and the current due to an applied e.m.f. represents correctly the current due to the electron vibrating under the same e.m.f. applied to the condenser plates of Fig. 4 (b).

Now, if the compliance is small (a stiff

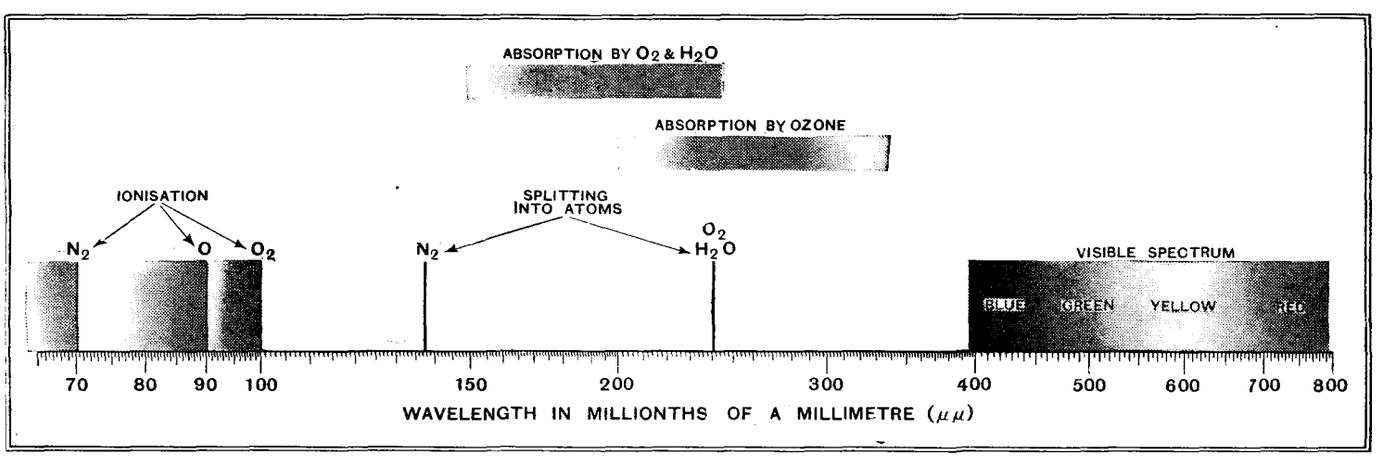


Fig. 1.—The solar spectrum showing the wavelengths responsible for splitting molecules into atoms and for ionising the constituents of air.

surmise, and more information is needed before the layers can be definitely labelled. Meanwhile, let us get down to the question which has probably been in the reader's mind for some time—a question which writers seldom answer except in formidable mathematical symbols—why are waves reflected from ionised regions?

Bending of Waves in an Ionised Layer

When light falls on a glass plate, as in Fig. 3 (a), it bends upwards by an amount which depends on the refractive index of the glass: the greater the refractive index the greater the bending. From a different point of view the bending occurs because light travels more slowly in glass, and so the wave front swings round as it crosses the surface. In fact, the speed of travel in glass is got by dividing the speed in air by n, the refractive index. Thus, if $n = 1.5$, an average value for glass, the speed in glass is reduced to $1/1.5$ of the speed in air.

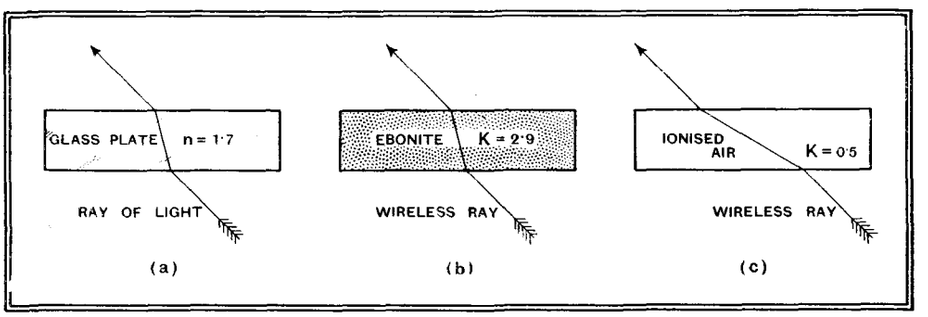


Fig. 3.—Wireless waves are refracted by ebonite just as light is refracted by glass because both have the same refractive index. But ionised air bends waves in the other direction because its refractive index is less than unity.

Wireless and the Atmosphere—

spring), the equivalent capacity C in Fig. 5 (b) is small, and the capacity reactance predominates. Hence, the current due to the electron leads the e.m.f. by 90 deg. Now, every atom in Fig. 4 (b) with its stiffly connected electron contributes a tiny capacity of this kind so that Fig. 4 (a) and (b) can be replaced by Fig. 6 (a) and (b), and we see that ebonite introduces a lot of capacities in parallel with the air condenser, and so the total capacity goes up. Thus we have now a physical picture of what the dielectric constant of ebonite means.

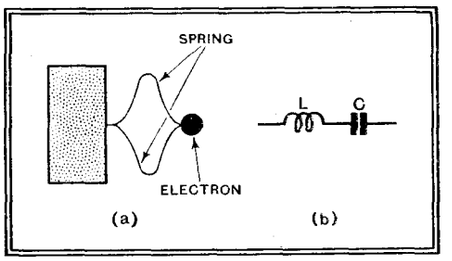


Fig. 5.—(a) An electron held by a spring force to an atom is equivalent to (b) a coil in series with a capacity.

The next step is to imagine the spring in Fig. 5 (a) getting weaker and weaker, and finally disappearing, so that the electron is free. As this goes on the capacity C in Fig. 5 (b) gets greater, and finally is so great that the reactance becomes purely inductive. Now, the picture is as in Fig. 6 (c), and the inductive currents lag by 90 deg. behind the e.m.f., and so are opposite in direction to the current due to the main condenser plates PP. This is more clearly seen in Fig. 6 (d), which is (c) redrawn, and shows that the total current is reduced by the presence of free electrons between the plates PP. In other words, the dielectric constant of the condenser is now less than unity.

The plates PP are only required as a convenient means of applying electric force. But in wireless waves the electric force is present anyhow, so that we can remove the plates, and we are left with ionised air in which the current, though still leading by 90 deg., is smaller than it would be in un-ionised air. That is, the dielectric constant K, and hence the refractive index is less than unity.

So the waves will bend down as in Fig. 3 (c), and we have made an important step towards understanding the behaviour of radio waves in the Heaviside layer.

Reflection of Waves

Now let us see how a ray may be brought down to earth again. If in Fig. 3 (c) the angle between the upgoing ray and the surface is made smaller, the refracted ray becomes more nearly horizontal, and at a certain stage just fails to enter the layer, but instead runs horizontally along the lower surface. Just beyond this stage there occurs what is known as total reflection, where there is no refracted ray and reflection occurs as from a perfect mirror, the sort of reflection which in the case of light takes place in the prisms of prismatic field-glasses (Fig. 7 (a)).

Again, if the ionisation increases in the layer in an upward direction, as it is sure to do, the bending increases continuously and we get the picture shown in Fig. 7 (b). Lastly, if the ionisation is anywhere so great that the dielectric constant becomes zero, we get total reflection at that point, even if the ray has been travelling vertically upwards (Fig. 7 (c)).

To sum up, then, we get reflection when in Fig. 6 (d) the current to the left (due to oscillating electrons) just balances the current to the right (the capacity current), and this must happen if the density of free electrons in a layer is great enough. In fact, this electron density can be calculated by noting the highest frequency at which reflection takes place. It can be shown that at this critical frequency $N = 0.0125 f^2$, where N is in millions of electrons per cubic centimetre and f is the frequency in megacycles (millions of cycles per second). Thus, in a particular case it was observed that wavelengths down to 53 metres were reflected by the Appleton layer, while for shorter waves no reflection took place. The corresponding frequency is 5.7 megacycles, and hence, from the formulæ $N = 0.4$, i.e., at that moment the maximum number of free electrons was 400,000 per cubic centimetre.

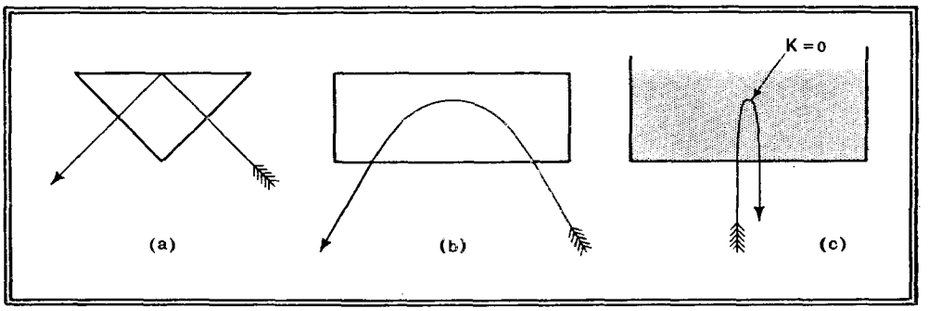


Fig. 7.—(a) Total reflection of light by a prism. (b) Continuous bending of wireless wave when ionisation increases in an upward direction. (c) Total reflection of wave when K=O.

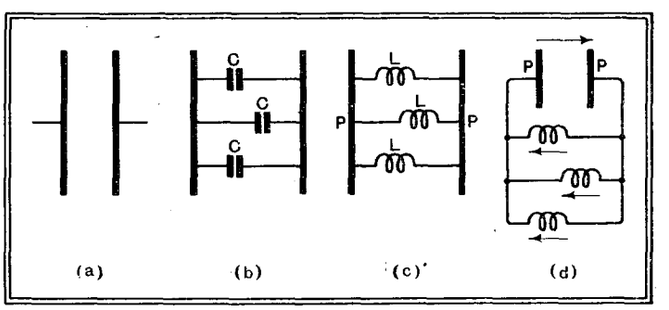


Fig. 6.—(a) Air condenser. (b) Equivalent of a mica condenser. (c) Equivalent of filling the space with free electrons.

Correction: In Part II of this series, p. 476, at foot of centre column, for "13 miles" read "13 inches."

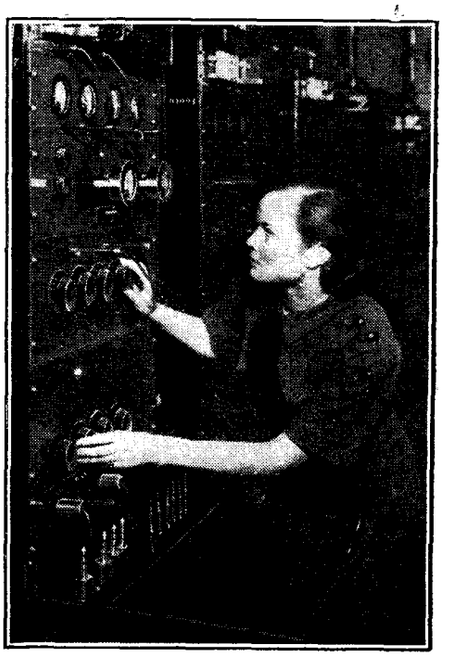
Woman Broadcast Engineer

Is She the Only One?

THE distinction of being Europe's only woman broadcasting engineer is claimed by Miss Natalie Piskor, who has been carrying out regular duties in the transmitting room of the Warsaw station for the past three years.

Miss Piskor, who is in her early twenties, told a correspondent of *The Wireless World* that she had always had a technical mind, and that her interest in wireless began when she repaired a receiving set for a friend many years ago. She took courses in radio telegraphy and passed her exams. with such success that she was immediately given a staff appointment by Polskie Radio.

Her services are in such demand that on several occasions when breakdowns have occurred late at night, Miss Piskor has been summoned to the station to help with the adjustments while wearing ballroom dress. She is accustomed to long hours at the control desk; in fact, monitoring every type of programme has become almost automatic.



The hand that rocks the modulator rules the world.

CURRENT TOPICS

Events of the Week in Brief Review

Higher Power from Sottens

SOTTENS is to increase its power from 25 to 100 kW., the new transmitter being supplied by a British firm.

Another "Luxembourg"?

IT is rumoured that a "Radio Luxembourg" of the South may be opened in Northern Africa to provide the countries of Southern Europe with international publicity programmes.

U.I.R.

THE Annual General Meeting of the Unione Internationale de Radiodiffusion is to take place from June 18th to the 26th at Warsaw. Members of the Union will be the guests of the Polish Broadcasting Company.

Germany Ceases Sponsored Programmes

THERE will be no further publicity programmes from German stations after this summer. Existing contracts for sponsored programmes on weekdays before noon terminate within the next two or three months and will not be renewed.

Short-wave Talks

SHORT-WAVE listeners will find something of genuine interest in the Tuesday ten-minute talks "Out of the Short-Wave Mail Bag" transmitted by W2XAF on 31.48 metres, from 10.35 to 10.45 p.m. (G.M.T.). These talks are given under the auspices of the International DX'ers Alliance.

Whitsun Motoring

THE many *Wireless World* readers who are keen motorists will be interested to know that this week's issue (Friday, May 31st) of our sister journal, *The Autocar*, is a special Whitsun number.

Hints for Whitsun touring at home and abroad are given, and a particularly useful feature deals with specially picked routes to the coast avoiding congested roads and those with speed restrictions.

Anti-Pirate Campaign

THE Danish radio licensing authorities have conducted a "drive" to round up pirates. The campaign was opened in the small provincial town of Slagelse (Sealand), where no fewer than 114 culprits were caught and fined 40 kroner each. Listeners all over the country are now flocking to the Post Offices to pay their licence fees.

Cap and Gown

A COMMITTEE has been formed by the International DX'ers Alliance of Bloomington, Illinois, U.S.A., to draft rules for acquiring the "Doctor of Short Waves" degree, entitling its holder to append to his name the letters D.S.W.

Anti-Static Lessons

A HIGHLY practical step to combat interference with radio has been taken by the Syndicate of French Radio Manufacturers, which is to hold a course of free lessons on the use of "anti-parasite" devices. The course will begin on Tuesday, June 11th, at the Laboratoire Central d'Electricite, 14, Rue de Staël, Paris, and will include five lessons and five periods devoted to practical work. Similar courses are to be organised throughout France.

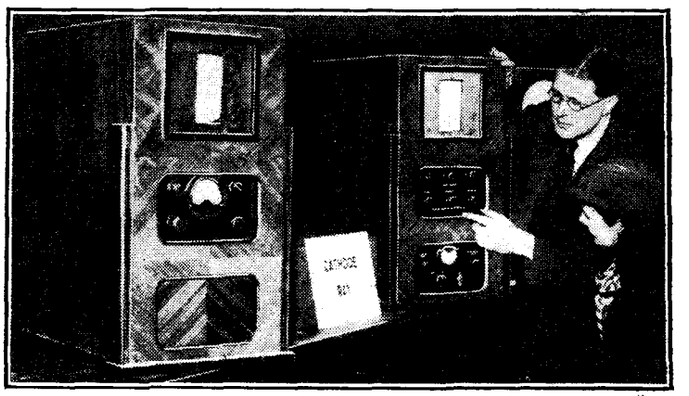
Irish Radio Show

THE Irish Wireless and Gramophone Exhibition is to held in the Mansion House, Dublin, from September 16th to the 21st next, under the auspices of the Irish Radio Traders' Association, Ltd.

Wireless Openings in R.A.F.

WIRELESS men will find scope for their activities in the expansion of the Royal Air Force. An entry of about 400 a quarter is required for training in the trades of armourer, wireless operator or photographer. Young men with a secondary school education, over seventeen and under thirty-two years of age, are invited to apply to the R.A.F. Recruiting Depot. Those accepted will be enlisted for six years' service on the active list, and will be given a course of training. On qualification they will receive pay at the rates of 3s. 3d., 4s., or 5s. a day according to their degree of skill.

To facilitate entry an enlarged recruiting depot has been opened under the Inspector of Recruiting at Victory House, Kingsway, London, W.C.2.



TELEVISION DEMONSTRATIONS. Popular interest in television is being abundantly revealed by the success of 30-line demonstrations in leading provincial cities by Mr. J. H. Reyner and his assistants, who use their own film transmitter with a Baird Mirror Drum, three types of cathode ray and two disc receivers. Manchester will be visited on June 17th.

Government Hour

FOLLOWING the German example, Roumania has now established a special Broadcasting "Hour" devoted exclusively to Government talks and propaganda. The inauguration ceremony was presided over by King Carol.

Another Rome Station

THE Italian Broadcasting Company has revealed plans for erecting a second 120-kW. medium-wave station at Rome. The power of the present station will also be increased from 50 to 100 kW.

The new station will employ a single mast of the anti-near-fading type such as is used at Budapest, some 300ft. in height, and will operate on the wavelength of the existing station, which will then be transferred to a shorter wavelength. The two stations will provide alternative programmes.

Small Ads. at Whitsun

THE approach of the Whitsun holiday necessitates slight alterations in our printing arrangements. Miscellaneous advertisements intended for inclusion in the issue of June 14th should reach the Publishers not later than first post on Friday, June 7th.

405-line Television

"WE are ready to supply high-definition transmitters capable of providing a public service of high-definition television with 405 lines and fifty pictures per second," said Lord Inverforth in his speech last week as Chairman at the Thirty-seventh Annual General Meeting of Marconi's Wireless Telegraph Co., Ltd.

Comparing British television progress with that in America, Lord Inverforth said that, whereas the Radio Corporation of America was about to spend money to "take television out of the laboratory," British television was already in the field of public service, though further heavy research expenditure must be embarked upon to improve and develop it.

Symptoms on the Ether

THE difficulty of describing symptoms of illness by wireless has been recognised by the International Committee for the Welfare of Sailors, and an interesting test will shortly be carried out by the Ostend Coastguard vessel "Zinnia" during a cruise in the English Channel and North Sea. A number of medical consultations by radio will be conducted between the vessel and stations on the Belgian, French, British, Danish, Norwegian and Dutch coasts.

5-metre Tests in Birmingham

OBSERVERS at Banbury and Daventry have reported reception of signals from the new 5-metre station, G6SL, of Stratton & Co., Ltd., in Birmingham. In the near future there are to be regular test transmissions on Sundays from about 10.30 to 1 p.m.

The transmitter comprises a straight line inductance oscillator with two Mullard TZO/25 valves in push-pull giving an output of 50 watts. The modulation portion for speech and music comprises a Class B amplifier with an output of 25 watts. The whole apparatus works from AC mains. The aerial system used in recent tests was beamed in the south-easterly direction and comprised four half-wave vertical radiators spaced a half-wave apart from each other, with four vertical reflectors a quarter of a wavelength behind each radiator.

High Fidelity Transmission Over Lines

A New System Described

THE advent of television has focused attention on the problem of devising telephone lines suitable for carrying the very wide range of frequencies required. The same need exists to a lesser degree for high-quality telephony, but it is in linking-up short-wave television transmitters that the most exacting requirements will have to be met. The following article describes some recent work on this problem.

A NEW scheme in the technique of electric-wave transmission over lines, which is likely to find application in the line transmission of high-definition television, as well as in other fields of radio communication, has recently been made known. It is due to L. Espenschied and M. Strieby, of the Bell Laboratories. Briefly, it is a system of lines and "repeaters" (i.e., amplifiers), whereby very wide bands of frequencies, up to a million cycles or more, may be transmitted with uniform over-all response for quite long distances over open-air lines or even over buried cables.

The transmission of radio-frequency currents over lines is not in itself a new idea. It has been much used, at low radio frequencies, for such purposes as carrier-current telephony and picture transmissions, but existing systems have been subject to severe limitations both in frequency-range and more particularly in the matter of interference.

The distinctive feature of the line part of the new system is the use of coaxial conductors, i.e., a single line completely surrounded by a coaxial tube, the line being centrally located and held in position by washers or other spacing device giving a minimum of solid dielectric between the conductors. Such a construction is illustrated in Fig. 1, but various other types adapted to particular conditions have been developed. The chief merit of this configuration is the high degree of "self-containedness" of operation afforded by it, i.e., a satisfactory degree of screening against external electric fields and a similar minimisation of interference with other neighbouring circuits—particularly at high frequencies. In fact, the higher the frequency the better the screening.

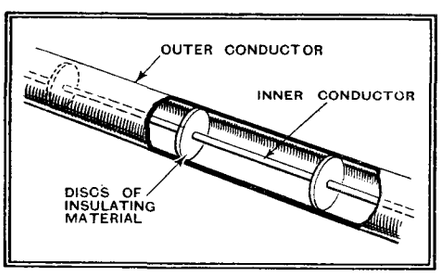


Fig. 1.—Sketch showing coaxial line with part of the casing cut away to reveal the central conductor and spacing discs.

Another advantage in comparison with ordinary cable pairs is the relatively small transmission loss, or "attenuation," as it is called, in a suitably constructed coaxial line. This is illustrated in Fig. 2, which shows that, by using a tube of sufficiently large diameter, the transmission characteristics can even be made superior to those of an open-air line. For those who are not quite at home with the decibel notation of this diagram, it may be pointed out that at 1,000 kc/s, for example, the fall of amplitude per mile would be to 0.94, 0.5, and 0.2 of the initial amplitude for a 2.5in. coaxial line, a 0.3in. coaxial line, and a No. 16 gauge cable pair respectively.

Even with the coaxial line, however, the attenuation is considerable, and, moreover, it increases with frequency, and would thus change the frequency-balance of a complex wide-band modulation, such as that of television, for example. This effect can be eliminated by something analogous to the now familiar process of tone-correction. That is to say, the line passes at suitable intervals through a "repeater" or amplifying station, where the transmission as a whole is stepped up to its original level, and at the same time the original frequency-balance is restored by giving a suitable frequency-characteristic to the amplification.

Special Advantages

It is in this part of the process that the advantages of the coaxial system are specially marked, for not only is the amount of needed frequency-correction reduced, but, owing to the high degree of screening, the general noise-level is low, and the desired transmission can be allowed to fall to a corresponding low level before amplification without unduly enhancing the noise : signal ratio. It is stated by the Bell Laboratories that even with a coaxial line as small as ½in. diameter a frequency-band of about a million cycles can be transmitted uniformly and without overall loss by a system with repeaters at intervals of about ten miles.

This wide-band amplification, however, involves the use of valve-coupling circuits of relatively low impedance, a condition which tends to accentuate cross-modulation and similar undesirable consequences of the non-linearity of valve characteristics. Here again the Bell System Laboratories have developed a new and special technique for minimising this trouble—a technique which, incidentally, may be useful in television amplification problems, apart from any question of line transmission. For reasons which have been given earlier in a paper by H. S. Black (*Bell System Technical Journal*, January, 1934), the introduction of reversed retroaction in a multi-stage amplifier, i.e., a feed-back in anti-phase instead of in phase, as in ordinary retroaction, results in a very considerable reduction in the cross-modulation and other consequences of non-linearity in the individual valve characteristics. It has been found practicable to extend this procedure to high frequencies, and thus to permit of amplification up to high levels even with the very extended band which can be transmitted in this new system.

One interesting point brought out in this article is the significant part played by temperature in the transmission characteristics of long lines. The attenuation is mainly due to ohmic resistance, and for high-frequency alternating currents the temperature coefficient of resistance, and therefore of attenuation, will be about 0.002 per degree Centigrade. This may seem too small to matter, but in a long line, even a coaxial line, it is by no means insignificant. Thus, for a fifty-mile line of 0.3in. coaxial cable it would be about 0.7 db. per degree Centigrade, and thus the attenuation might easily vary with temperature beyond the ±2 db. limits considered permissible.

Means for eliminating this variation have been devised in the development of the wide-band system. Details are not given, but the main idea is the utilisation of two pilot frequencies—probably somewhere near the limits of the band transmitted. These are presumably made to control the amplification-level in the repeater station, and so

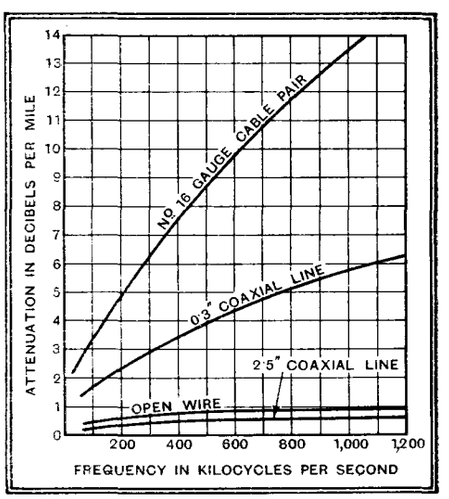


Fig. 2.—Curves showing the relation between attenuation and frequency range.

counteract any variations due to temperature change. It is claimed that the desired regulation can be maintained to within a few tenths of a decibel.

It does not appear that any actual transmissions of television modulation have been carried out, but it is proposed that such modulation should first be translated by one or more modulation and filter processes to a range—such as 100 to 1,100 kc/s—suitable for the coaxial-line transmission, and restored to its original location in the spectrum by a reversal of these processes at the receiving end. It sounds ambitious, but the modern communication engineer seems to find no difficulty in carrying out complicated manœuvres with columns of frequencies, and the proposal is by no means impracticable.

BROADCAST BREVITIES

By Our Special Correspondent

UNCAPSIZABLE MICROPHONE STAND in use at the Zoo last week. Mr. Derek McCulloch is seen introducing an elephant to the Children's Hour audience.

Door Slamming on Little Nationals

HAVE you noticed interfering bubble sounds on the "Little Nationals"? The B.B.C. engineers, answering complaints on the subject, have stated that the trouble has been due to instability in the synchronising equipment. This condition is, of course, fatal, as the smallest variation causes distressing results.

Technical observers in different parts of the country are being asked to concentrate on reception of these three stations and to report any bubbles, "door slam" noise, or other interference.

This "door slam" business is a new one on me, and I shall add it to my steadily growing dictionary of technical slang.

Ribbon Mikes as Standard

THE metal ribbon microphone is fast becoming the standard model so far as London broadcasting is concerned. Six specimens are being installed in the Maida Vale studios, and others will soon replace the older "mikes" in St. George's Hall, the Broadcasting House Concert Hall, and studios 8A and 8A.

Better High Notes

I hear that the discarded microphones are to be used for Queen's Hall concerts, the reason being that it has been noted that Queen's Hall transmissions have been weak on certain high frequencies—a fault which the older instruments are likely to rectify.

Not in the Provinces

Apparently ribbon microphones are not being sent to provincial studios on account of difficulties with pre-amplifiers, which demand more technical experience than engineers outside London have yet had.

"Dear Nunky . . ."

THEY are smiling at Broadcasting House over an "indiscretion" by a gentleman who has recently been employed by the Corporation in the preparation of programmes.

To brighten up a feature programme he wrote to an uncle abroad inviting the good man to participate in a forthcoming broadcast. Naturally the note was couched in familiar, not to say affectionate, terms, but, unfortunately, the scribe used B.B.C. notepaper . . .

In future, letters to one's own mother, if on B.B.C. notepaper, must begin "Dear Madam."

Where Are the Women Organists?

WOMEN artists are as versatile as men and play instruments ranging from the flute to the saxophone, but there are very few women organists. One of the select company is Miss Aileen Bransden, who is in the National programme list for a recital at 1.30 p.m. on June 5th on the fine organ in the parish church of St. Luke, Chelsea.

Tauber Consents

I HEAR that Stanford Robinson, the B.B.C. conductor, was personally responsible for winning over Richard Tauber, who, now that the clash of rumour and counter-rumour has died down, is definitely scheduled to broadcast on June 19th on the National wavelength from 10 to 11 p.m. in a programme compiled by himself.

Singer and Conductor

Tauber himself will conduct the B.B.C. Theatre Orchestra between the groups of songs, which, by the way, will contain at least six with which he has made a world reputation. The provisional programme includes Volga-Lied (Der Zarewitsch), by Lehár; Vilja-Lied (Die lustige Witwe), by Lehár; Immer mir Lacheln (Das Land des Lächelns), by Lehár; (*a*) Sonja ich liebe Dich, (*b*) Du bist die Welt für mich; two songs from "Der Singende Traum," by Richard Tauber; Ballad (Blossom Time), by G. H. Clutsam.

Musical Ear

Tauber's musical sense is so highly developed that in rehearsal he frequently corrects orchestration by ear, detecting, while singing, a wrong note played by a single instrument among many.

It will be no new experience to Stanford Robinson to be accompanying Tauber in his songs with the Theatre Orchestra, for in the famous tenor's latest film, "My Heart's Delight," Stanford conducts the orchestra and is actually seen doing so in the film.

Broadcasts from Radio Olympia

NIMBLE Eric Maschwitz and his fleet-footed lieutenant, John Sharman, are already at work on programme arrangements for the B.B.C. show at Radiolympia in August.

They tell me that there will be three relays from the exhibition of an hour each. The first will probably be on Wednesday, August 14th, the second on Saturday afternoon, August 17th, and the last on August 24th.

New "Expressionist" Radio Drama

WHAT may be described as the first Expressionist broadcast play ever heard in this country is to be broadcast on June 13th. This will be "The South Sea Bubble," a dramatic chronicle by Cecil Lewis, who has reverted to playwriting.

The tale of the first great crash in the City demands a very big canvas. The glamours of making a fortune out of the unknown South American continent seized royalty, ministers, fine ladies, simple country squires, footmen, apprentices, the very urchins in the street; many, ruined and dishonoured, destroyed themselves; the remainder lived on with their dreams of luxury shattered and their reputations destroyed.

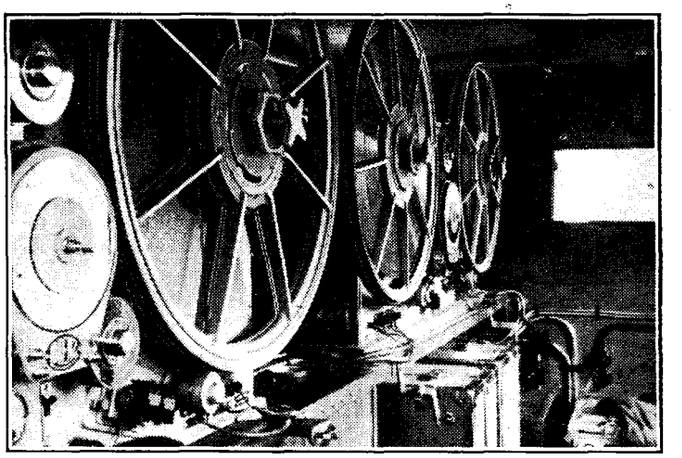
By means of a new technique Cecil Lewis will recreate those six months when the whole country went mad and when shares which had stood at below 80 soared to 1,050 before the cataclysmic crash.

Revivals

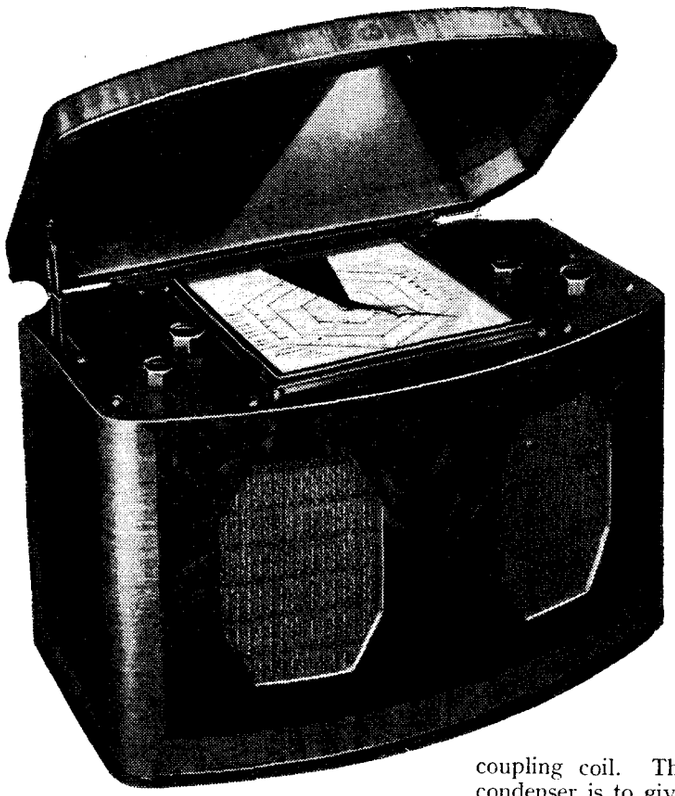
IN spite of the host of new writers nurtured by the correspondence schools, few appear to be able to produce original work of a kind likely to satisfy the B.B.C. Dramatic Department.

Summer radio drama reminds one of a Revival Meeting, for we are to have "Hassan" revived after five years; "The Lost Horizon," eighteen months; and "Sir Christopher Wren," again brought to life after four B.B.C. performances and innumerable electrically recorded versions from Empire stations.

By the way, Whitaker Wilson, author of "Sir Christopher Wren," is now at work on a programme dealing with the Spanish Armada.



A MOBILE RECORDING UNIT. A glimpse inside the newest recording van of the German broadcasting organisation. The steel tape can secure continuous records while the van is in motion.



McMichael

Model 135

An AC Superheterodyne with a Novel Tuning Scale

FEATURES.—***Type.***—*Table model superheterodyne for AC mains only.* ***Circuit.***—*Triode-pentode frequency-changer—var.-mu pentode IF amplifier — double-diode second detector — pentode output valve. Full-wave valve rectifier. (1) Tuning. (2) Volume and on-off switch. (3) Tone. (4) Waverange.* ***Price.***—*15 guineas.* ***Makers.***—*McMichael Radio Ltd., Slough, Bucks.*

THE circuit of the latest McMichael superheterodyne follows conventional practice in general outline but there are several points of interest in relation to detail. There are four valves comprising a frequency-changer, IF amplifier, second detector with AVC, and a pentode power output valve. Instead of the usual double-diode-triode in the second detector stage a special Cossor double-diode valve has been employed, and the whole of the LF amplification is carried out in the final stage.

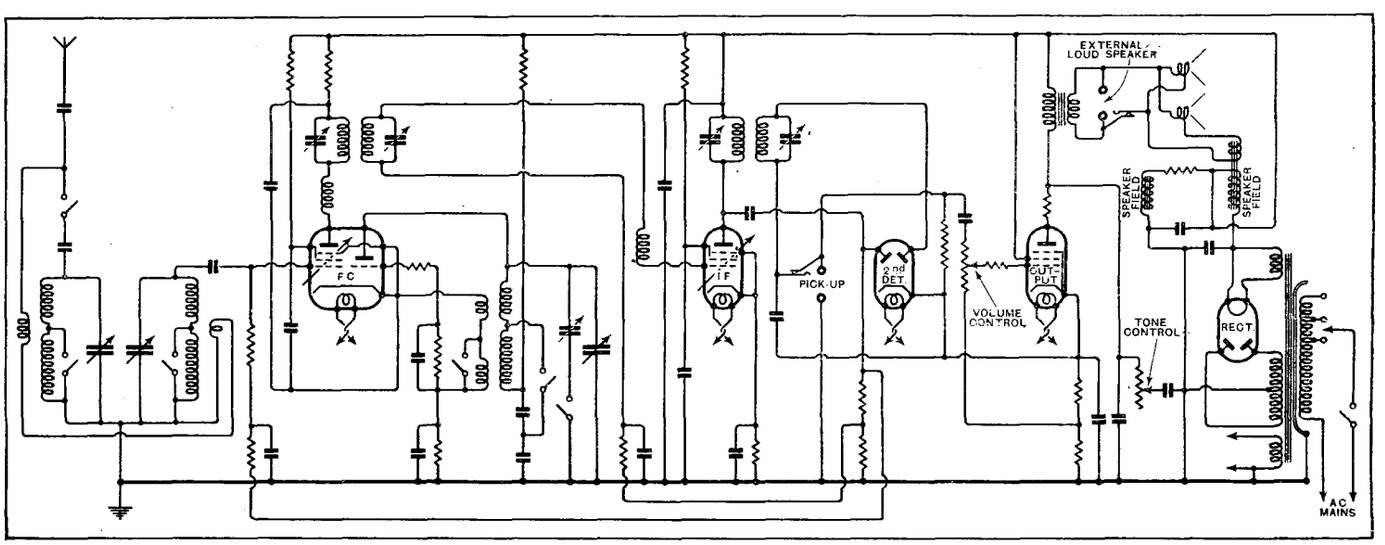
At the input end of the circuit there are also several points of interest. The band-pass input filter is self-coupled, the tuned circuits being wound on a common former with suitable spacing between the windings. In order to ensure uniformity of response throughout the medium-wave range the aerial resonant circuit is fed through a small series condenser as well as through a coupling coil. The effect of the series condenser is to give a better input at the high-frequency end of the scale. The LF coupling coil on the front in conjunction with the aerial capacity is arranged to resonate in the neighbourhood of 450 kc/s, thus giving an increase to the low-frequency end of the scale. It is claimed that the resultant of these two effects keeps the aerial input constant within 25 per cent. over the medium-wave band. On long waves the series condenser feed is disconnected, the coupling being made through the aerial primary winding in the usual manner. Second-channel interference is minimised by feeding a small out-of-phase voltage component from the aerial input to the low potential end of the secondary tuned circuit.

The satisfactory functioning of the second-channel suppressor circuit appears to depend upon an efficient earth, for when the earth lead became accidentally detached from the receiver during the tests quite a prominent whistle appeared near the North Regional transmitter. Normally with a proper earth connection this would pass quite unnoticed. Another fault which developed without the earth lead was a region of instability on the long-wave range. With the earth lead properly connected the behaviour of the set was exemplary in every way, and we draw attention to this point only to show that it is not always wise to rely on the capacity earth returned through the mains leads which is sufficient in the case of many sets.

Quiet Background

In view of the fact that the McMichael Model 135 is fitted with a shielded primary on the mains transformer it was only to be expected that the background noise is also considerably reduced when a proper earth connection was used.

That the sensitivity and range of the set will more than satisfy the requirements



A carefully designed aerial circuit results in more than usually high selectivity in the four-valve superheterodyne circuit.

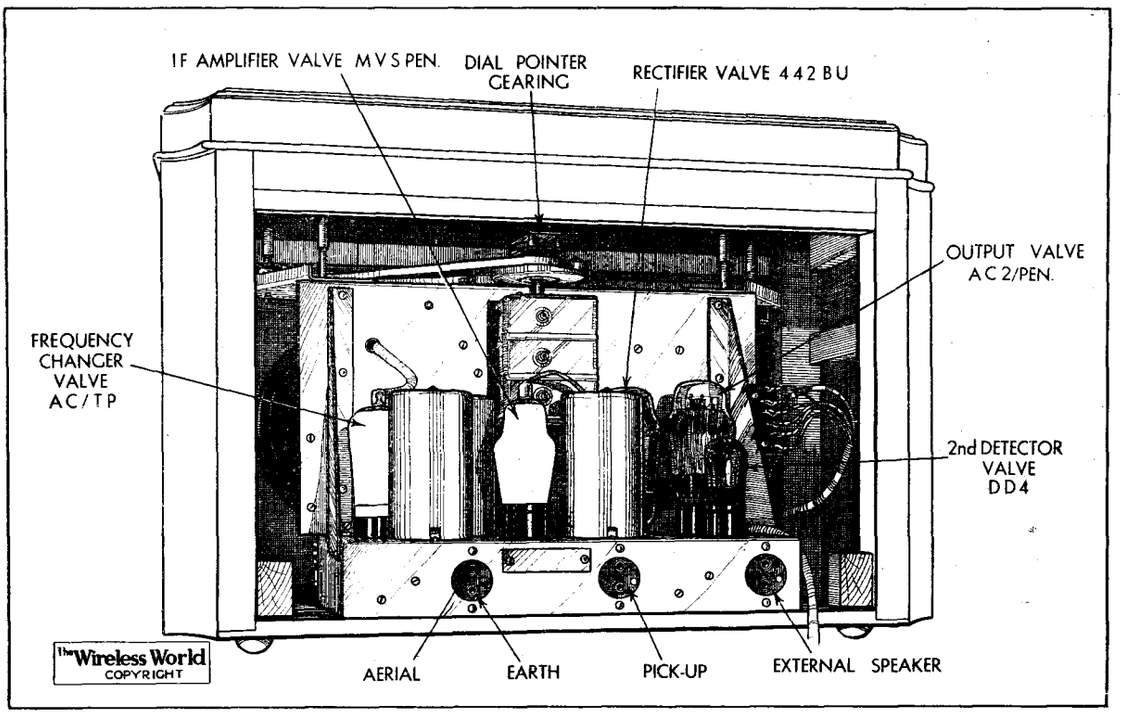
McMichael Model 135—

of listeners who look to the Continent as much as to this country for their wireless programmes is beyond a shadow of doubt. The selectivity is certainly above the average, and appears to be much more uniform over the medium-wave range than is general. On neither of the Brookmans Park transmitters was any interference detectable in Central London outside a band of 9 kc/s on either side of their normal settings. In other words, not more than one channel would be lost under these conditions. On long waves the Deutschland-sender was quite easily received clear of Droitwich and Radio-Paris without having to call upon the tone control to reduce noise due to side-band interference. From the last statement it follows that the long-wave selectivity was even higher than that on the medium-wave band and some over-emphasis of the bass was evident on long-wave stations when absolutely accurately tuned.

The quality of reproduction as regards frequency range is very much the same as that of other superheterodynes in this class, but there can be no doubt that the use of dual loud speakers not only improves the naturalness of the bass response, but disperses the sound generally and obviates the "corridor" effect which sometimes results from the focusing from a single loud speaker unit.

The front of the cabinet in which the loud speaker apertures are situated is convex, and the rounded corners give strength to the comparatively thin walls, which prevents the formation of wood resonances which might spoil the otherwise smooth qualities of the bass response. From every point of view the cabinet design is pleasant to look upon, and is unusual without breaking entirely from conventional standard.

Undoubtedly the most interesting feature of the design as a whole is the large rectangular tuning scale. This is explored by a 4in. pointer which is geared to give nearly a 360 deg. rotation, which, combined with the large diameter of the scale, gives much greater ease of tuning. The last fraction of a degree is so magnified when tuning-in a station that the absence of a tuning indicator does not make itself apparent. The scale is "floodlit" by a strip light inside the lid, and a part of this light also shines through a small monogram let into the front edge of the lid, thus indicating whether the set has been accidentally left on. The necessity for this tell-tale is in itself a sufficient indication of the low level of background noise.



The chassis controls pass vertically through the top panel of the cabinet, the central control being geared to give an open wavelength scale.

Next Week's Set Review—
WURLITZER
ALL-WAVE SUPERHET

Short-wave Broadcasting

AT the moment of writing, conditions on the short waves seem to be as unreliable as the weather. The past two or three days have been of the kind when "locals," normally weak, assume fantastic strengths. All this, needless to say, happens at the expense of the distant stations, which fade right away for a period.

Some of the very powerful European commercial stations—notably HAS2 in Budapest—are apt to be extremely troublesome when conditions of this sort prevail.

Owners of unselective receivers are apt to hear HAS2 from one end of the short-wave spectrum to the other; and there are even cases on record of his having been heard on the medium- and long-wave broadcast bands! His wavelength, incidentally, is in the region of 23 metres.

HVJ, the Vatican City station, usually associated with the wavelength of 50.26 metres, has been coming in at tremendous strength on his other setting of 19.84 metres. Some of the test transmissions in preparation for the relaying of the Canonisation Service on May 19th were particularly well received in this country, although they were primarily intended for New York.

The congestion on the 31-metre band is becoming serious, and Sydney's Sunday afternoon transmission is sometimes very difficult to receive, unless one is using a very selective superheterodyne. The two German stations, DJA and DJN, working close together, cause enough interference, but when one has Madrid (EAQ), Geneva (HBL), Rome (12RO), and Lisbon (CT1AA) all in the band as well, things are really difficult!

W1XK, on about 31.36 metres, is a new call-sign for the old station W1XAZ at Springfield. W1XK is located at Millis, Mass., and relays the medium-wave programmes of WBZ and WBZA.

One or two readers have reported good reception of the programmes from CR7AA (Mozambique) on 85 metres. Considering that we do not usually associate the 80-metre amateur band with long-distance work (except for Americans in the early mornings), this reception is remarkable.

Ponta Delgada, Azores (CT2AJ), has also been heard, working on 75 metres. These two stations both use powers of the order of 100 watts only.

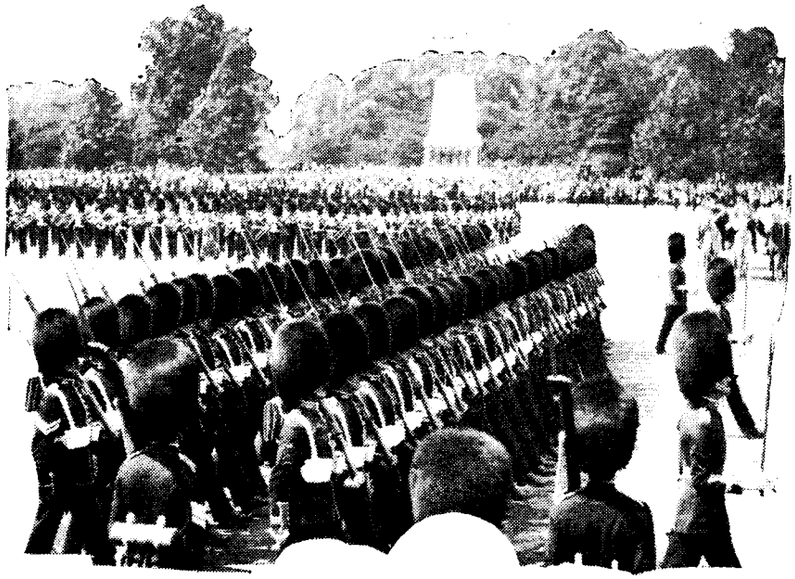
The B.B.C.'s announcement of its decision to install two new transmitters at Daventry for the Empire service will gladden the hearts of many overseas listeners.

Similar plans, however, are afoot in many other countries, and one wonders what the short waves will be like in a few years. Indications are that medium-wave history will be repeated—transmitters of higher power will be built to overcome interference difficulties, and they, in their turn, will increase the interference. And so the world moves on!

Ultra-short-wave broadcasting seems to be on the increase in the U.S.A. Over a dozen stations are now listed below 7 metres; whether they really provide a valuable programme service we do not know. It almost seems, however, that the U.S.A. could be effectively covered by means of short-wave and ultra-short-wave transmissions only.

MEGACYCLE.

Listeners' Guide for the W



TROOPING THE COLOUR will be broadcast from the Horse Guards Parade at 10.45 a.m. on Monday next (National). Few broadcasts need so little comment, for the "picture" grows out of the brilliant and varied assortment of sounds which include the ceremonial "March Past," fanfares and drum taps.

A GOOD WEEK

THE last lingering signs of post-Jubilee depression are swept away by the programmes of the next seven days, which are of the quality one might expect in mid-winter, when the listening season is at its height. It is true that the B.B.C. is again hankering after the glamours of Vienna (Good-night but not Good-bye, Vienna), though much may be forgiven them in view of the wealth of programme offerings which have nothing to do with the Austrian capital.

"BITTER SWEET"

TO-NIGHT (Reg.) and to-morrow (Nat.) we have Noel Coward's romantic operetta "Bitter Sweet," for which the versatile playwright wrote not only the book but the music; and Evelyn Laye is playing her original part of Sara. Playing opposite to her is Serge Abranovic, who for long deputised for Richard Tauber in the Lehár operettas.

In to-night's performance the interesting experiment is being made of separating the first and second acts, the B.B.C. Dance Orchestra providing an entr'acte of Noel Coward selections.

TROOPING THE COLOUR

THE two main outdoor broadcasting events next week are the Trooping of the Colour on Monday and the Derby on Wednesday.

The Trooping of the Colour on the King's birthday (June 3rd) begins at 10.45, the ceremony opening with the arrival of the Royal Procession and the Royal Salute. His Majesty the King inspects the troops, after which the massed bands and drums of the Brigade of Guards play a slow march, counter march, halt and a quick march. The Sergeant Major receives the Colour and hands it to the Ensign for the Colour. The Escort salutes the Colour by presenting arms, and bands and drums play "God Save the King." The commentary on the ceremony will be given by Major J. B. S. Bourne-May in the National programme from 10.45 a.m. to 12 noon.

THE DERBY BROADCAST

MR. R. C. LYLE will, as usual, describe the Derby on June 5th at 2.35 p.m.

The Derby course follows a rough horseshoe formation inclining down hill at the start and up hill at the finish. Since the shortening of Tattenham Corner the course has measured exactly one mile, four furlongs and five yards. The record for the new course is held jointly by "Hyperion" (1933) and "Windsor Lad" (1934) who covered it in two minutes and forty-four seconds, two-fifths of a second faster than "Call Boy" in 1927. The Derby Stakes, first contested in 1780, are now worth about £6,000.

30-LINE TELEVISION

Baird Process Transmissions.

Vision 261.1 m. Sound 296.6 m.

MONDAY, JUNE 3rd.
11.15-12.0 p.m.
"Sky Line"—a Tour of New York by Television, with Billy Milton, Sara Allgood, Georgie Harris, Rieta Nugent.

WEDNESDAY, JUNE 5th.
11.15-12.0 p.m.
"Sky Line" (repeat performance).

SCRAPBOOK OF 1905

VERY appropriately Leslie Baily and Charles Brewer are including a vignette of Derby Day thirty years ago in their "Scrapbook" of 1905 on Wednesday evening (Nat. 8.30).

The year 1905 was one of general prosperity. The music-hall was in its heyday, with such stars as Vesta Tilley, Albert Chevalier, Marie Lloyd, and Alfred Lester. The stage suffered the loss of its greatest figure, Sir Henry Irving, and the memory of him will be contributed to the programme by Seymour Hicks. The "*Entente Cordiale*" was cemented by King Edward's visit to Paris and the French fleet's visit to England. There were 7,500 hansom cabs on the London streets, and it was in 1905 that the last steam train ran on the underground railways.

TOSCANINI

THE presence of Toscanini in London next week brings one of the principal musical events of the year—the final concerts of the London Music Festival.

Arturo Toscanini, who has never previously conducted a British orchestra, has an immense following in Europe and America. He was born in Parma in 1867, and at the age of 31 became chief conductor of the Metropolitan Opera House in New York.

TOSCANINI. An exclusive picture of the great conductor, who directs two broadcast concerts this week at the Queen's Hall as part of the London Music Festival.

In Monday's broadcast at 8.30 p.m. (Nat.) there will be heard the Symphony No. 4 in E Minor by Brahms and Siegfried's Death and Funeral march ("Götterdämmerung") by Wagner, and both these are to be repeated in Wednesday's concert (Reg. 8.30).

Preceding the Monday concert will be an explanatory talk by Dame Ethel Smyth, Mus. Doc.

eek Outstanding Broadcasts at Home and Abroad

FIFTY TO ONE

A. J. ALAN, whose identity is wrapped in as great a mystery as any he has recounted at the microphone, will broadcast on Derby Day (Nat., 10), and it is significant that the title of his tale is "Fifty to One."

ST. PAUL'S ORGAN RECITALS

ORGAN-LOVERS will welcome the first of a new series of recitals on the beautiful instrument in St. Paul's Cathedral. Dr. Stanley Marchant, who gives the first recital in the Regional programme on Tuesday evening (June 4th), will include in his programme works by Handel, Stanford, and Schumann.

CEMETERY BROADCAST

A BROADCAST from a soldiers' cemetery is included in the Strasbourg programme at 8.45 to-morrow evening, June 1st, when the nineteenth anniversary of the Battle of Verdun will be commemorated. There will be a military band concert from Verdun, and at 10 o'clock will be heard the ex-soldiers' service from the cemetery at Douamont.

OPERA

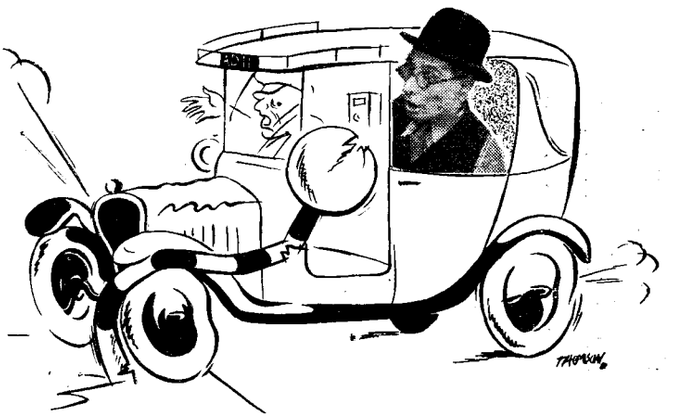
GRÉTRY'S opera, "Richard Cœur-de-Lion," should draw many English listeners to the Radio-Paris wavelength at 8 o'clock to-morrow evening (Saturday). On the same evening at 8.55 Rome broadcasts Bellini's opera, "I Puritani."

The French National Orchestra will be taking part in the broadcast from French State stations of Niccolo's three-act opéra comique, "Joconde," on Tuesday at 8.30. Another choice for opera-lovers on the same evening is Donizetti's "Lucia di Lammermoor" on records from Warsaw at 9 o'clock.

PRIMA-DONNAS IN JUNE FOOTBALL MATCH

TO-MORROW (Saturday) in Norway is Oslo Day—a day of homage to the Norwegian metropolis. The day begins with an "O.B." and running commentary on the procession of the "Oslo Princess," elected for a day as the flower of Oslo's female populace. The fair sex, indeed, plays a large part in the festivities. In the afternoon at 4.30 there will be a relay of a strange football match between journalists and prima-donnas of the Oslo theatres, ranging from music-hall stars to Shakespearian actresses.

The evening programme will be filled with gay music from various restaurants, music-halls, and other public places of enjoyment.



TAXI! Claude Dampier, "professional idiot," plays a long-suffering part in Monday's "Variety in a Taxi" programme on the Regional wavelengths.

A CHOPIN RECITAL from Warsaw, the home of the composer, is always worth tuning in. Here is Sophie Rabcewicz, who plays a number of Chopin pieces, including the Bolero in D, at 9 p.m. on June 5th.

HAYDN COMMEMORATION

THE birth of Haydn is to be commemorated by Huizen this evening in a programme, starting at 7.55, consisting of the Symphony No. 8 in B flat, played by the Maestricht Municipal Orchestra; a play, "Haydn's Last Visitor," by Fortner; and the 'Cello Concerto in D, by the same orchestra, with Raphael Lanes ('cello). Haydn was born on March 31st, 1732.

LUNAR INFLUENCES

"A MOONLIGHT CONCERT" is offered by the Eiffel Tower at 8.30 on Sunday evening, and the programme includes, of course, Beethoven's Moonlight Sonata, played by Canot, and there will be other music inspired by lunar influence. Maria Banèze will sing.

SERIOUS JAZZ

AN amateur musician who a few months ago had never written a line of music will contribute to a "serious" jazz-rhapsodic concert in Copenhagen at 9.35 to-morrow (Saturday) given by Louis Preil's radio orchestra. He is Knud Bentzen, whose very original and descriptive work "Peter's Dream," should be well worth listening to.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, MAY 31st.

Nat., 4.45, Union Day Programme from South Africa. ¶B.B.C. Dance Orchestra. ¶B.B.C. Orchestra (D), conducted by Malcolm Sargent.
Reg., 7.45, "Bitter Sweet." ¶Harry Roy and His Band.

Abroad.
Leipzig, 8, Opera: "Der Waffenschied" (Lortzing).

SATURDAY, JUNE 1st.

Nat., B.B.C. Orchestra (E). ¶"Bitter Sweet."
Reg., American Half-Hour. ¶Horsham Borough Silver Band. ¶Ambrose and His Embassy Club Orchestra.

Abroad.
Vienna, 10.10, Concert of Austrian Music by the Symphony Orchestra.

SUNDAY, JUNE 2nd.

Nat., Violin Recital by Marjorie Hayward. ¶Commodore Grand Orchestra. ¶Margate Municipal Orchestra.
Reg., B.B.C. Military Band. ¶Guitar Recital by Segovia. ¶Eva Turner in Operatic Programme with B.B.C. Orchestra (D).

Abroad.
Brussels II, 8, Symphony Concert from the International Exhibition. Rachel Thauvoye (Harpsichord).

MONDAY, JUNE 3rd.

Nat., 8.30, Arturo Toscanini conducting London Music Festival Concert at Queen's Hall.
Reg., Viennese Programme by B.B.C. Northern Orchestra. 8.30, Variety in a Taxicab.

Abroad.
Brussels I, 8, Walloon Music by a Symphony Orchestra.

TUESDAY, JUNE 4th.

Nat., "Old Music Halls," arranged by M. Willson Disher. ¶"Freedom," by John Moore.
Reg., St. Paul's Cathedral Organ Recital. ¶"Liebelei" (Schnitzel)—Pre-war Viennese Romance.

Abroad.
Poste Parisien, 9.5, Triple Concerto for Pianoforte, Violin and 'Cello.

WEDNESDAY, JUNE 5th.

Nat., 2.35, "The Derby." 8.30, "Scrapbook of 1905." 10, A. J. Alan.
Reg., B.B.C. Military Band. ¶Café Collette Orchestra. 8.30, Toscanini conducting Wagner Programme (London Music Festival).

Abroad.
Kalundborg, 8, Danish Music by the Radio Orchestra.

THURSDAY, JUNE 6th.

Nat., "Liebelei." ¶B.B.C. Midland Orchestra in Music of Glinke.
Reg., Variety from the Winter Gardens, Morecambe. 9, "Scrapbook of 1905."

Abroad.
Warsaw, 10.15, Concert by the Station Symphony Orchestra, with Wilkomirski ('Cello).

Foundations of Wireless

Part XXIII.—Other Output Valves

THE somewhat critical operating conditions of the output pentode are discussed at length, with particular reference to the reduction of harmonic distortion. A treatment of the basic push-pull circuit, with its QPP and class "B" variants, is included in this instalment.

By A. L. M. SOWERBY, M.Sc.

BESIDES the triode, other types of valve are used for driving a loud speaker. Since, with the tetrode, the signal must never be allowed to swing the voltage at the anode below that at the screen (see Part XXI), this valve is not suitable for this use. But the pentode, in which secondary emission is suppressed, can, if suitably designed, act as output valve.

Compared with the triode, the pentode offers the dual advantages of being more *efficient*, in the sense that a greater proportion of the power drawn by its anode circuit from the HT supply is converted into AC power for operating the speaker, and of being more *sensitive*, in that a volt of signal applied to its grid produces a larger output. For these two reasons the pentode has very largely supplanted the triode as output valve.

Screened and output pentodes differ in minor points, but not in principle. In the latter, since screening is no longer vital, grid and anode are both taken to pins in the base. High output is obtained by designing the valve to operate with a screen voltage little, if at all, below that at the anode.

In Fig. 122 are reproduced the curves of a typical indirectly heated output pentode; their similarity to the usable portion of the curves of a tetrode will at once be evident. We see again the high AC resistance (curves nearly horizontal) typical of a valve using a screening-grid between control-grid and plate.

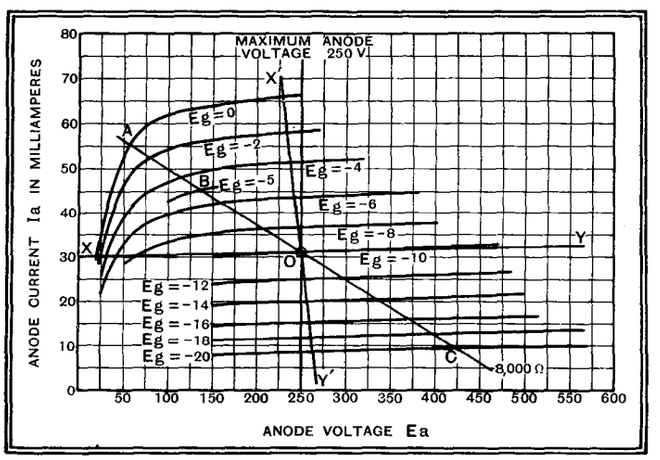


Fig. 122.—Curves of a typical indirectly heated output pentode. The load-line ABOC represents a usual load. Curves taken at Es = 200.

In the case of a pentode, the usual triode rule that the anode load should be approximately double the AC resistance of the valve does not hold. At the working point O ($Ea = 250$ V., $Eg = -10$ V., $Ia = 31$ mA.) the impedance of the valve is some 125,000 Ω (change in Ia of 2 mA. brought about by change in Ea of some 250 V.); XOY is a load-line representing 250,000 Ω drawn through O. Towards X it cuts the curves for $Eg = -8$ to $Eg = 0$ in very rapid succession, while towards Y it looks as though it will never reach the curves for $Eg = -12$ to $Eg = -20$. With a load such as this, the application of a signal swinging the grid from 0 to −20 would very evidently result in the most appalling distortion, together with the development of amazingly high audio-frequency voltages at the anode. (At what value of Ea does the line XOY cut the curve $Eg = -20$?)

Excessively Light Loading

If we were to fly to the other extreme and draw a load line (X'OY') representing a very low load, distortion would again result, owing to the line now cutting the curves for high bias in very rapid succession, while the intercepts with the low-bias curves are widely spaced. Since these two types of distortion, for high and low loads respectively, occur at opposite ends of the total grid-swing, it is fairly evident that some intermediate load is going to be found best.

We are led to the same conclusion if we consider the power developed (still for the grid-swing 0 to −20 V.) in the two loads. XOY offers high voltages and negligible current, while X'OY' provides high current but negligible voltage. To get both voltage and current reasonably large an intermediate value of load is clearly required.

Let us investigate an 8,000-Ω load, which experience suggests as a possible load for a pentode. This is indicated by the line ABOC. The power delivered to this load when a signal swings the grid from $Eg = 0$ to $Eg = -20$ can be obtained, as with a triode, from the voltages and currents at the points A and C; it is

$$\frac{(56.2 - 9.2) \times (424 - 56)}{8} = \frac{47 \times 363}{8}$$

$$= 2{,}160 \text{ mW.}$$

How about distortion? With the triode, as we have seen, the distortion anticipated is second harmonic distortion, and we accepted the convention that the permissible limit of this is 5 per cent. With the pentode we have to take into account distortion equivalent to the introduction of both second and third harmonics of the original signal.

In Fig. 123 is plotted the dynamic characteristic of a triode working under conditions of 5 per cent. second harmonic; the data for this are taken from the load-line XOY of Fig. 120 (Part XXII). To show up the non-linearity of the curve, a straight line joins its extremities; the divergence between the current at the actual working point O and that shown, for the same bias, on the straight line, is the measure of the second harmonic distortion. Calling the currents at X and Y respectively $Imax$ and $Imin$, that at P is midway between the two, or $\frac{1}{2}(Imax + Imin)$. The difference between this and Io, the actual current at O, divided by the total current swing $(Imax - Imin)$, gives the proportion of second harmonic, requiring only to be multiplied by 100 to give

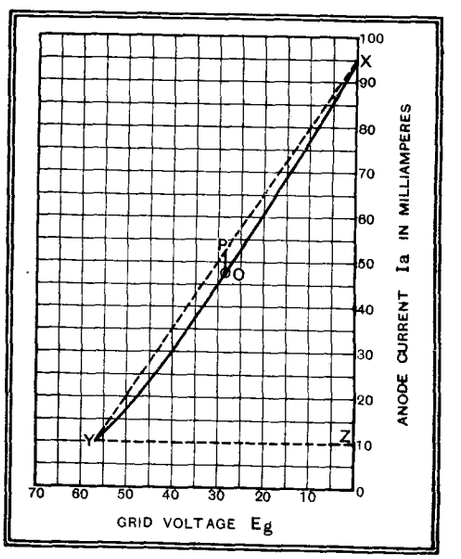


Fig. 123. Dynamic curve of output triode giving 5% second harmonic distortion, and, in dotted line, ideal characteristic for no distortion. Percentage 2nd harmonic $= \frac{PO}{XZ} \times 100$.

Foundations of Wireless—

the percentage. The formula for calculation is thus:

Percentage 2nd harmonic =

$$\frac{\frac{1}{2}(I_{max}+I_{min})-I_o}{I_{max}-I_{min}} \times 100.$$

To introduce third harmonic, as with the pentode, the curve must bend *both ways*, as in Fig. 124, which shows the dynamic curve of a valve introducing about 12 per cent. third harmonic, but zero second. Freedom from second harmonic is shown by the fact that O now lies on the straight line joining A and C, but it will be seen that the curve lies below the line between C and O, and above it between O and A. This particular type of divergence from linearity always implies third harmonic. It can be numerically estimated in exactly the same way as

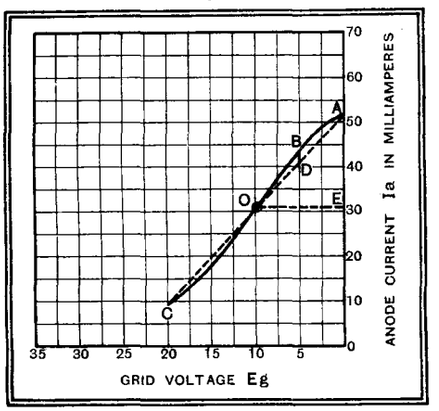


Fig. 124. Dynamic curve of pentode with 10,000-ohm load. Ideal characteristic giving zero 2nd and 3rd harmonics is shown dotted.

Percentage 3rd harmonic = $\frac{BD}{AE} \times 100.$

second harmonic distortion, using now, of course, only *half* the curve. It is found from the difference between the actual current at B and the current at D, which, being on the straight line, is the mean between the currents at O and C, this difference being divided by the total change in current in passing from O to A. The upper half of the curve is taken for the estimation because it is found to show a greater harmonic percentage than the lower.

Comparison of this figure with Fig. 122, which is similarly lettered, will show that third harmonic distortion, once its source is recognised, can be found by reading off the appropriate current values from the usual family of curves without troubling to draw the dynamic characteristic for the load under consideration.

By drawing a number of load-lines across the curves of Fig. 122, and calculating second and third harmonic distortion for each, the results summarised in the curves of Figs. 125 and 126 have been obtained. The difference between the two sets of data is that in making the calculations for Fig. 125 it was assumed that the signal had a peak voltage of 10 V., thus swinging the grid between zero and −20 V., whereas in Fig. 126 the calculations have been made for an 8-volt signal, swinging the grid from −2 to −18 V. only. As might be expected, the distortion is much less for the restricted input.

In both cases the second harmonic distortion is high for a low load, but drops away to zero as the load is increased. This is the load for which the dynamic characteristic has the form shown in Fig. 124. Still higher loads reintroduce second harmonic distortion, which then rises rapidly with increasing load. Third harmonic distortion, as the curves show, increases steadily with increasing load, as does the power delivered to the speaker. It is from a number of curves such as these, calculated not for one but for several alternative working points, that the final operating data for a pentode are determined by its designer.

The "high-slope" pentode, at present much used in certain types of set, only differs from the standard type by requiring a much smaller signal-voltage. A typical valve of this class will yield about 2,500 milliwatts in return for a signal of 3 V. peak, instead of the 10 V. needed by the standard pentode we have been discussing.

If more power is wanted than can be provided by a single output valve, two (or more) may be used. By simply adding a second valve in parallel with the first, connecting grid to grid and anode to anode, the swings of voltage at the anode are left unchanged, but the current swings are doubled. So, therefore, is the power, while the load needed for two valves is half that needed for one. The performance of the whole output stage can be deduced from the $Ea-Ia$ curves of one of the valves merely by multiplying the figures on the anode-current scale by the number of valves it is proposed to use.

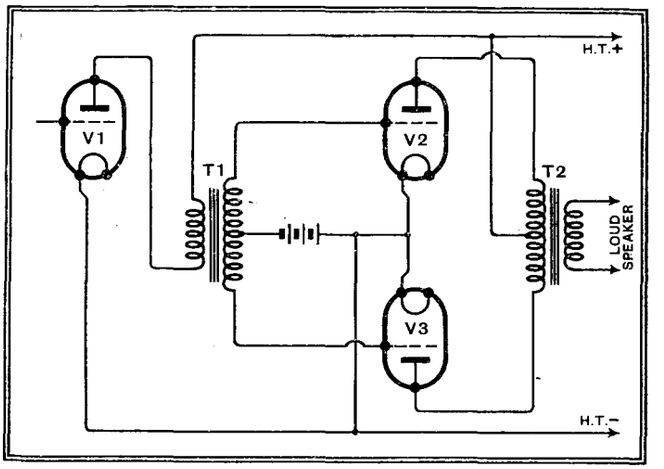


Fig. 127. Two output valves, V2 and V3, in push-pull. The same circuit also applies to QPP and class "B," the differences being only in the operating voltages and choice of valves.

Alternatively, the valves may be connected in *push-pull*, as shown in Fig. 127. Here the output valves are fed from a transformer T1, in which the mid-point, instead of one end, of the secondary is earthed. At an instant when, with the normal connection, the "live" end of the secondary would be at +20 V., the other (earthed) end being at zero potential, the centre-point of the winding would be at +10 V. With the push-pull arrangement this centre-point is brought to earth potential, the two ends, therefore, being respectively +10 and −10 V. Thus each valve receives half the available voltage, the two halves always being in opposite phase.

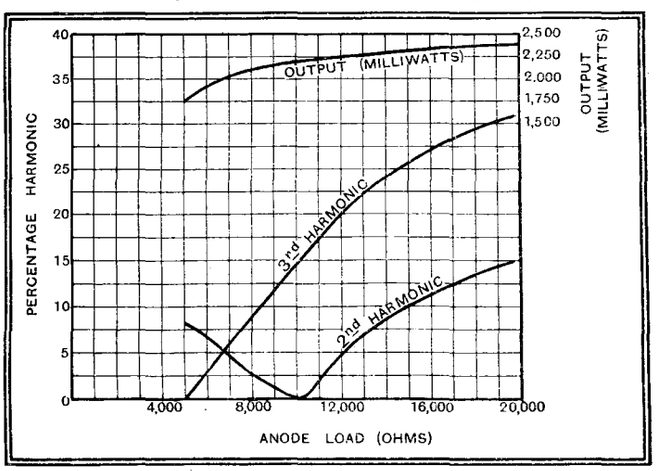


Fig. 125.—Output and 2nd and 3rd harmonic distortion for pentode of Fig. 122. Working-point O; input signal 10 V. peak.

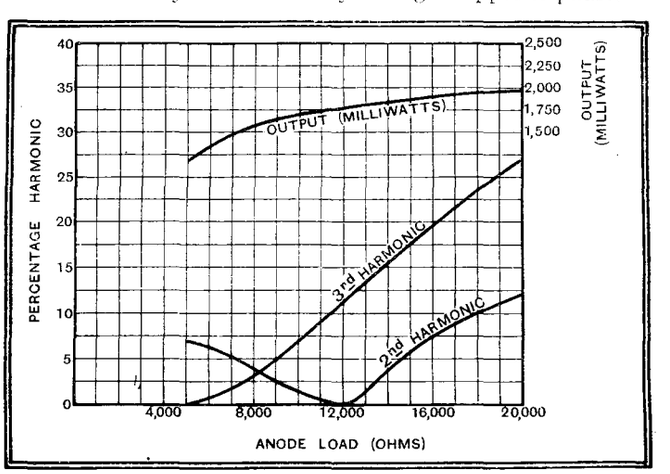


Fig. 126.—Output and 2nd and 3rd harmonics for pentode of Fig. 122. Working-point O; input signal 8 V. peak.

Foundations of Wireless—

The resulting out-of-phase anode currents, which would cancel one another if passed in the same direction through a transformer, are made to add by causing them to flow through separate halves of a centre-tapped primary, as shown at T2 in Fig. 127. The voltage induced into the secondary, and hence the current flowing in the loud speaker, is due to the combined currents of the two valves.

This mode of connection has several advantages over the more obvious parallel arrangement. These are:—

(1) The steady anode currents, since they pass in opposite directions through their respective primaries, cancel one another so far as polarisation of the core of the transformer is concerned. A smaller transformer can, therefore, be used for two valves in push-pull than for the same two valves in parallel.

(2) Signals fed through the common HT connection cancel; valves in push-pull are, therefore, unable to feed magnified signals into the HT line of a set, and so give rise to feed-back. Conversely, disturbances on the HT line (hum, etc.) cancel in the two valves.

(3) *Second* harmonic distortion produced by either valve is cancelled by equal and opposite distortion from the other. Two *triodes* in push-pull will, therefore, give a greater undistorted output than they would if connected in parallel.

Third harmonic distortion does not cancel in this way. Pentodes, whose output is limited by third harmonics, consequently give no greater output in push-pull than in parallel. Advantages (1) and (2), however, apply to pentodes as much as to triodes.

Economy in HT Consumption

If valves, whether triodes or pentodes, are over-biased, the distortion arising is mainly second harmonic distortion. With two valves in push-pull, this type of distortion will automatically vanish. Two valves in push-pull may, therefore, be given so large a bias that their anode current is reduced practically to zero, making them behave, on receipt of a signal, as though they were anode-bend detectors. So biased, the valves of Fig. 127 will each amplify only during the moments when its grid is made more positive by the applied signal, during which instants the anode current rises in proportion to the signal voltage applied. If the valves would normally be biased to -10 V., each would then require a 20-volt total grid swing, making the total swing on the transformer secondary 40 volts. Both valves would then amplify at every instant, and the standing anode current might perhaps be 20 mA. per valve, remaining unchanged on the application of the signal.

Now, suppose each valve biased to -20 V., and the signal doubled. The no-signal anode current might now be only 3 mA. per valve, the two valves giving alternate kicks up to 40 mA. when the full signal is applied. *At full output* the total average anode current remains 20 mA., as before, and the available output power is unchanged, but if the applied signal is well below the maximum that the valves can handle, the average current, made up now of alternate kicks up to perhaps 6 mA., is quite small. Since, on a musical programme, the full output of the valves is only called for at brief and infrequent moments, this trick of overbiasing results in a very large overall saving of anode current without curtailing the available output. In mains sets, where anode current costs practically nothing, this device is hardly ever used; in battery sets, where anode current costs perhaps twenty to one hundred times as much, it has found wide application. The system is called *quiescent push-pull*, commonly abbreviated to QPP, and specially designed output valves are offered by several makers. Owing to the need for doubling the input signal, the less sensitive triode is seldom used, each half of the QPP output valve being usually a pentode.

Another quiescent output scheme, designed to economise anode current, is found in the *Class "B"* output stage, which again uses the basic circuit of Fig. 127. In this case the two output valves (usually combined in one bulb) are high-impedance triodes taking, as in QPP, only a small anode current except when a signal is applied. The bias used is at most small, with the result that *the grids are swung heavily positive* by the signal. Grid current inevitably flows, thereby consuming audio-frequency power; the preceding valve must therefore be so chosen that it can deliver this power without overloading, while the transformer feeding the Class B valve must be a properly designed *"driver"* transformer of the correct ratio and of low DC resistance. By removal of the no-grid-current limitation large powers can be obtained from a Class "B" output stage at the cost of a remarkably low average anode current.

As in the case of output stages of other types, the fullest details of the performance of push-pull, QPP, or Class "B" output stages can be obtained by careful study of the appropriate $Ea - Ia$ curves.

Random Radiations

By "DIALLIST"

The Naval Review

ON July 16th the Outside Broadcast Department of the B.B.C. will undertake one of the most difficult jobs that it has as yet handled. That day will see the first of the eye-witness accounts of the Naval Review at Spithead, which will be given by observers in the foretop of the Royal Sovereign. Just how the O.B. Department is going to tackle the noise of big guns fired within a short distance of the microphone when the salutes are given I don't quite know; but they have proved themselves in the past such fine hands at overcoming difficulties that I am sure they will make a success of the Naval Review broadcast.

The commentators are two naval men, Commander D. M. Stride and Lieut.-Commander Woodriffe, so that listeners can rely upon receiving a correct account with none of the mistakes that a mere landlubber might make. Altogether broadcasting from the Royal Sovereign will take place on five days, and these commentaries should be amongst the most interesting of those that we shall hear during the coming months.

"O.B." a Dangerous Trade ?

Two remarkable accidents have occurred recently in connection with Outside Broadcast work, one in our islands and the other in Austria. Readers may remember that one of the B.B.C.'s O.B. staff was mauled by a tiger whilst he was engaged in fixing up the microphone for a children's hour relay from the Belfast Zoo. One would imagine that an accident of that kind should never have been allowed to happen; surely the tiger might have been kept penned up in its sleeping den.

The Austrian mishap had, unfortunately, a tragic sequel, though this time nothing more ferocious than a capercailzie was the subject of the relay. A cyclist collided with one of the cars conveying material. He was killed and both the driver of the car and an electrician were badly injured. Ravag proudly records that in spite of the accident the relay of the bird's cry was successfully accomplished.

Just Knobs

IT has long been a mystery to me why some manufacturers choose to fit their sets with wretched little tuning knobs of very small diameter, some of them very awkwardly shaped. When you are operating a selective set nothing makes tuning easier than a knob 1½ or even 2 inches in diameter with a lightly milled or roughened edge. But a little knob, particularly if it is of some fancy shape, cramps your fingers and is much harder to turn. Another point not always appreciated is that the larger the radius of the knob the bigger is the movement of its circumference necessary to turn the dial which it drives through one division. Hence, with a knob of reasonable size fine tuning is appreciably easier.

Through the Weather-House

THE radio weather-house which attracted so much attention at last year's Olympia Exhibition has produced, so to speak, a sequel in the form of a book "Through the Weather-House," by R. A. Watson-Watt. Very interesting reading it is, and completely free from deep depressions. He calculates, for instance, that with electricity at a farthing a unit the value of a lightning flash is something like a halfpenny a yard. A day of artificial sunshine would cost every man, woman and child in England £50, though in Scotland, with its less dense population, the price would work out at nearly five times as much. There are all kinds of other thrilling calculations.

Miraculous Batteries

IT is amazing what some people think the primary electric battery can do. In detective stories one comes across the battery of death-dealing EMF which the super-crook carries concealed in cigarette case or wallet. But perhaps the first prize for inventive genius must go to the gossip writer who recounted that a foreign visitor (unnamed) to

this country was causing a sensation by wearing illuminated earrings.

Tiny batteries, it was explained, were tucked away in each, and the brightly glowing lamps illuminated by their aid caused every beholder to turn and admire. I wish I could come across some of those marvellous batteries, which appear to be almost like Euclid's point in size and to weigh next to nothing, though they deliver watts and watts and watts for hours on end.

Car Radio Licences

NOW that summer is more or less with us, I am receiving a good many enquiries about the question of licences for car radio sets. The position was clearly defined last year, but it may be as well to remind those who have forgotten the terms of the announcement then made. Under your ordinary receiving licence you are entitled to establish a receiving station and to operate both "fixed" and portable sets in your own home and a portable set outside it. If, therefore, you merely take a portable out in your car you are covered by the one licence. But the receiving set built into a car is quite a different affair. When the wireless set is part and parcel of the car's equipment a second receiving station is established, and an additional ten-shilling licence is necessary. In the licence itself permission is given to establish a receiving station, not at a certain address, but in a motor vehicle of registration number so-and-so.

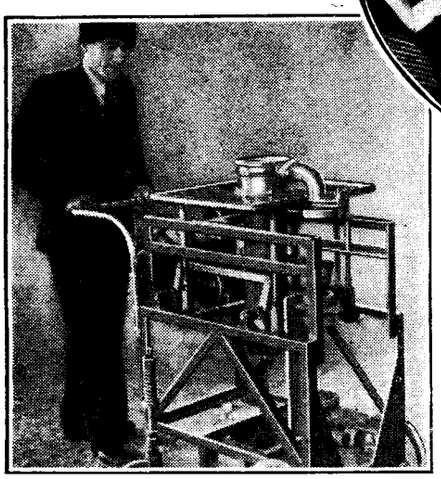
Melting Magnetos

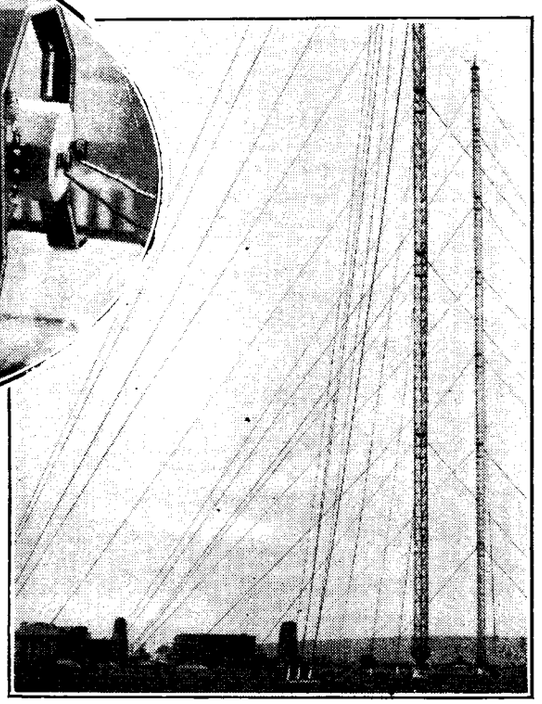
NO month is really complete nowadays without its discovery of a death ray. During May we have had accounts of no less than two, so that May has done pretty well. The first blossomed forth as a result of the Marconi demonstrations for the benefit of Signor Mussolini. Marchese Marconi himself promptly denied that he was engaged in stopping motor cars or anything of the kind. His demonstration appears to have been connected with developments on the ultra-short waves upon which he has been engaged for a long time now. Next came the information that a German inventor claimed to be able to melt the magnetos of cars and aeroplanes at distances of up to a couple of miles by means of a secret ray. He may, of course, have discovered something which wrecks insulators at that range, but there are so many pretty little problems involved that I remain sceptical. Anyhow, one would imagine that efficient screening would settle the hash of any magneto-melting ray.

"Radio Romania"

New 150 kW. Station Now Testing

By a Special Correspondent.





Miss Elise Porusnic is one of three women announcers on the staff at "Radio Romania." She holds the degree of Doctor of Law. The valve carriage on the left will remind readers of our pictorial description of Droitwich, where similar equipment is used. "Radio Romania" is also a product of the Marconi Company. The aerial masts are 830 feet high.

IN the days of less sensitive receiving sets listeners in Western Europe were always proud to be able to log reception of Bucharest, as the signals travelled overland for a distance greater than those from almost any other transmitter; even nowadays the prospective traveller to Rumania always thinks twice about it, for the journey entails at least a day and a night in the train. Luckily for those who wish to visit that part of Europe the German Lufthansa have started a daily service which takes you from Berlin to Athens via Budapest and Belgrade in under twelve hours.

By leaving Berlin at 7 o'clock in the morning I reached Belgrade in time for lunch and with sufficient time for a business visit, and then continued in the late afternoon to Bucharest, the capital of Rumania. The reason for this sudden decision to leave for the little Paris of the East is not hard to find. By the time these lines appear in print "Radio Romania" (the official name of the new high-power station) will have just started tests in the early morning hours.

The new 150 kW. station at Brasov, a small town in what might well be termed the geographical centre of the country, promises to be "the big noise" of South-Eastern Europe. Not only will Rumanians throughout the country obtain easy reception of the national programmes on crystal sets, but those countries which have inadequate broadcasting services, or none at all, will now obtain a reliable daytime transmission. To the older generation Brasov will probably be more familiar under its German name of Kronstadt. It is on the main line from Budapest to Bucharest.

The transmitter has been placed a few miles out near the sugar factory of Bod. The transmitter and the two aerial masts, which are 830 feet in height, are products of the British Marconi Company. The Diesel engines which provide the power for the transmitter come, however, from Switzerland. These burn heavy oil which costs a fraction of what it does in countries less blessed with oilfields.

The official opening of "Radio Romania" is expected some time in June.

Brasov will receive its modulation along land-lines from Broadcasting House at Bucharest, where the studios are comparable in efficiency and comfort with those of Britain and Germany. The Rumanian Broadcasting Company, who have kept well abreast of the latest technical developments, have just acquired a site for the building of an entirely new "Broadcasting House," although the present one is only just five years old.

UNBIASED

By FREE GRID

The Lost Chord

I WONDER if readers can help me in an apparently vain quest for a mysterious station?

The other day I was down among the short waves a little below 40 and, like the man at the organ, I was feeling weary and ill at ease while idly twiddling the keys, or rather the dials. The cause of my lack of ease was the new boots which I was wearing, coupled with the fact that it was in the small hours of the morning when, so medical men assure us, human vitality is at its lowest ebb, all the pubs having long since closed.

Now one of my hobbies is the identifying of foreign languages, and it is my proud boast that there is very little that baffles me, not even Manx. I do not, of course, claim to be fluent in, or even to speak, the wretched languages, but merely to recognise them when I hear them. I am sufficiently proficient, for instance, to be able to distinguish Siamese from Static, which, as students of oriental languages will know, is no mean feat.

However, I was, as already related, idly twiddling the dials when suddenly I heard a voice speaking in an unknown tongue. It lacked entirely the rhythm of any class of language known to me and, in fact, resembled nothing so much as the sound of the last dregs of bath water running down the waste pipe. I was still more amazed when the announcement

"Weary and ill at ease"

ceased, and a programme in the English language commenced, of a type which would bring a blush of shame even to the hardened cheeks of a boulevardier of Montmartre or Manchester. It was apparent from the accents of the artistes that the programme was not emanating from any English-speaking country nor, indeed, from any other country known to me, for although I can identify the nationality of any foreigner by his accent when speaking English, I was entirely unable to place this one.

Volume was good, with so truly remarkable an absence of fading that I might have been receiving the programme via the direct ray from a nearby station instead of, as I presume, from some distant land.

Since then I have spent many feverish and sleepless nights in an endeavour to get this mysterious programme once again, but all to no purpose. I am, in fact, becoming quite haggard and worn over the whole affair, and I can, for the first time in my life, sympathise with the unfortunate organist in his quest for the mislaid chord.

A Jubilant Issue

SINCE the Jubilee spirit is still in the air it is not out of place to remind my readers that next April this journal celebrates its own Jubilee, having first seen the light of day on All Fools' Day, 1911.

Celebrations of events of this character have to be considered for many months in advance, and already I have been entrusted with the task of preparing a special Jubilee issue for next April. I am at present at a loss as to what to put in the issue, and it has occurred to me that some of the more kind-hearted of you might care to assist me to fill its pages. Surely there must be many of you with literary aspirations, whilst others may be glad of the opportunity to give vent to their pent-up feelings in cold print. Reminiscences from readers-from-the-first-number will be especially welcomed, but for obvious reasons birth certificates must be enclosed.

Floreat Borstalia

I HAVE received so many letters lately asking what are my academic qualifications for dealing with the many technical matters that crop up from time to time in my weekly contribution to the world's knowledge that I think it would be all to the good if I gave a brief résumé of my career.

Intended by my father for the profession of the law, I found myself at the bar at a comparatively early age, in fact, almost as soon as I had passed the legal age of fourteen years, and from that time honours fell upon me thick and fast. After a short term of Government employment, necessitated by a misunderstanding concerning a signature on a cheque, I went out to Australia to visit scenes made familiar to me by the writings of my great-grandfather—one of the earliest colonists sent out there by the Government over a hundred years ago.

Failure to pass the educational tests necessary to secure a landing permit compelled me to return home, where I was fortunate enough to inherit an old-established plumbing business from an uncle just about the time that the great radio boom began. Needless to say, this happy coincidence resulted in a great extension of the business, not only in the legitimate activities of accumulator charging and repair—for after all the literal interpretation of the word "plumber" is "a worker in lead"—but also in the more

My fame spread

profitable business of set designing and repairing.

Having inherited from my father some small skill as a musician it was not long before I learned to fashion and play a wind instrument of my own. My success as a trumpeter may be judged by the fact that my fame spread beyond these shores and secured the well-merited attention of certain foreign universities and other seats of learning.

In record time I secured a diploma from overseas, this being followed some time later by a peremptory demand for ten dollars "to defray the cost of packing and postage." With my receipt came sundry pamphlets bringing to my notice the fact that when my business had expanded sufficiently to permit of my raising the necessary fee, further and greater honours awaited me.

In due course I made the necessary application for these honours, but owing to some regrettable misunderstanding—due, I believe, to the poor quality of my handwriting—I was sent a theological diploma in place of the one for which I had applied.

[These reminiscences must now cease, otherwise the identity of Mr. Free Grid may emerge and a contributor be lost to us in the renewal of a term of service in Government employ.—ED.]

New Apparatus Reviewed

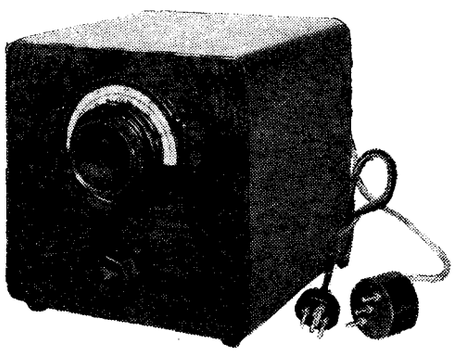
Recent Products of the Manufacturers

K-B SHORT-WAVE CONVERTER

THE K-B short-wave converter is a neat and compact single-valve frequency changer which is intended to be used with those K-B broadcast sets in which is provided a supply point giving the HT and LT voltages required by the converter. It covers a wave-range of 15 to 80 metres in two stages selected by a switch, their respective bands being 15 to 40 metres and 35 to 80 metres.

The dial is wavelength-calibrated and traversed by a pointer attached to a very smooth-running slow-motion drive, the reduction ratio of which is nicely suited to the needs of short-wave tuning. It is positive in its action and free from backlash or slip.

Our tests were made with a 1934 model K-B 666 receiver. The 15- to 40-metre band proved to be by far the better during the time of test, although late night listening was attempted. The American W2XAF, W2XAD were good stations from a programme point of view, whilst W8XK, on 19.72, and also on 25.27, was good and very strong signals were obtained most evenings from Zeesen DJA and DJN.



K-B short-wave converter covering a wave-band of 15 to 80 metres.

Among other stations received well were PRF5, Rio de Janeiro, VK2ME Sydney, as well as most of the B.B.C. Empire short-wave stations, all below 40 metres. The higher range was not so productive as the lower, no doubt the conditions prevailing at the time being more favourable for the latter. Occasional "dead-spots" were noticed on the 35- to 80-metre band, but they did not extend over more than a metre on the scale.

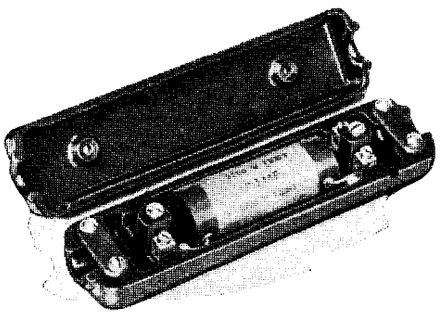
Several stations were heard, but few actually identified on this band; amateurs were very active at times towards the upper end of the scale just below 80 metres.

This unit is very convenient to operate as there is one control only apart from the wave-band switch, and change-over to the normal broadcast wavelengths does not entail its disconnection, a turn of the switch being all that is necessary.

The converter is assembled in a well-made and highly polished walnut cabinet, and the price is £4 10s., the makers being Kolster-Brandes, Ltd., Cray Works, Sidcup, Kent.

BELLING-LEE FLEX-LEAD SUPPRESSOR

THIS small compact device has been developed by Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middlesex,



Belling-Lee interference suppressor for small portable electric appliances.

for inserting in the mains supply lead to portable electric appliances, such as vacuum cleaners, floor polishers, drills, etc., fitted with small motors or vibrators, its purpose being to serve as an interference suppressor for appliances in which no provision is made for earthing the frame.

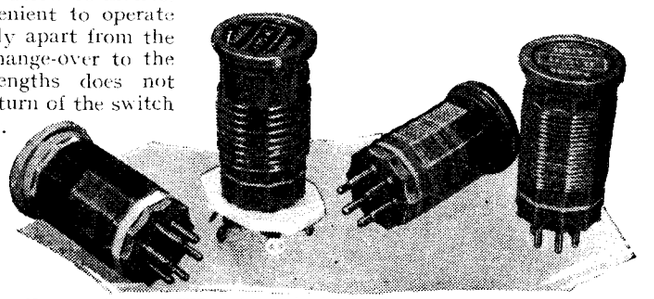
The device consists of two condensers assembled as a single unit and enclosed in a narrow moulded bakelite box, the various wire connectors being totally enclosed and fully insulated. One condenser of 0.1 mfd., tested at 1,500 volts, is joined across the mains supply, while the other, of 0.01 mfd., connects one supply lead to the frame of the machine. This condenser is tested at 2,200 volts.

The capacities used and the test voltage applied to each comply with the recommendations laid down by the Radio Component Manufacturers' Federation, so that adequate protection is provided in this unit.

The price is 6s.

HAMMARLUND SHORT-WAVE COMPONENTS

THE Hammarlund Manufacturing Co., Inc., of U.S.A., have for long specialised in the production of high-quality short-wave components; their latest types now employ a new special low-loss dielectric material which is claimed to be particularly good at the very high frequencies. Some specimens of their latest products have been sent in for examination by R. A. Rothermel, Ltd., Rothermel House, Canterbury Road, London, N.W.6; these comprise a set of four coils and bases.



Hammarlund SWK-6 kit of four short-wave coils and new 6-pin Isolantite coil base.

The coils are of the 6-pin plug-in variety and each has three separate windings. The set covers a wave-range of from 17 to 270 metres, using a tuning condenser of 0.00014 mfd. with an adequate overlap between each. The 17 to 41-, 33 to 75- and 66 to 150-metre coils have secondary windings of silver-plated copper wire, while the primary and reaction in each case consists of double silk-covered wire, the primary being interwound with the secondary.

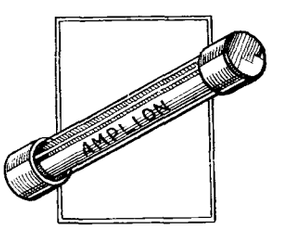
The 135 to 270-metre coil is wound with enamelled wire for the secondary, the other windings being of DSC, and in every case the secondary is space-wound. The coil formers are 1¼in. in diameter, have ten ribs, and measure approximately 3in. high.

On test the coils were found to be exceedingly efficient, the windings all nicely proportioned, and as the self-capacities of the tuned windings are small each coil has a wide waveband coverage, especially when tuned by a 0.00015 mfd. condenser as customarily used in this country, and the ranges marked on the coils are easily realisable if reasonable care is taken in keeping stray capacities small.

The set of four coils known as the SWK-6 kit costs 22s. 6d., and the new style Isolantite coil base 3s. An SWK-4 kit consisting of four coils as in the first-mentioned but with each coil former having two windings only is available at 17s. 6d.

AMPLION FUSES

CARTRIDGE fuses of the type now generally used in wireless receivers, and also in sundry small electrical appliances operated from the supply mains, are now ob-

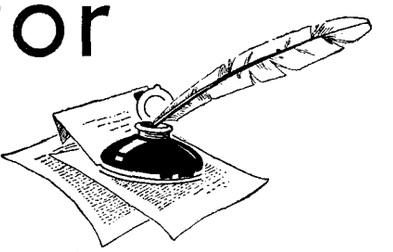


Amplion small cartridge fuse, available in all standard sizes.

tainable from Amplion (1932), Ltd., 82/84, Rosoman Street, Rosebery Avenue, London, E.C.1.

They range in current handling capacity from 60 mA. to 3 amps., and there are ten different models in all, colour coded for identification as recommended by the Radio Components Manufacturers' Federation. Metal end-caps, ¼in. in diameter, are fitted, and the fuse container measures 1¼in. long. Tests have been made with several different models, and in every case the fuse blew at an overload of approximately 60 per cent., thereby affording adequate protection for its type. They cost 6d. each.

Letters to the Editor



The Editor does not hold himself responsible for the opinions of his correspondents

The Quartz Crystal

THE interesting article on "Single Span Tuning and the Quartz Crystal" in your issue of May 24th illustrates the fact that the quartz crystal provides the solution to many of the outstanding problems of receiver design. In addition to its high selectivity, the crystal can be employed to give either or both sidebands at will. These two features thus enable us to deal with both types of interchannel interference—the interfering programme and sideband splash. The resonance curve is thus ideal, being capable of giving one sideband with a high value of carrier component.

Such an ideal receiver from the selectivity point of view would not be satisfactory if the frequency response were bad. However, the full frequency response can be given, and it is obtained without any danger from harmonic distortion. Mr. Cocking in his article suggests that when the balancing condenser is adjusted to give one sideband there is a possibility of such harmonic distortion. He obviously has in mind the fact that single sideband systems are prone to such distortion when the percentage modulation is high. It is, however, now well established that such distortion diminishes rapidly as the percentage modulation decreases, and, in fact, at a recent meeting of the I.E.E. on May 1st, when Captain Eckersley talked on Asymmetric Sideband Transmission, a large part of the discussion centred round this point, and in particular the Chief Engineer of the B.B.C. gave some figures to illustrate the point.

The high selectivity of the quartz crystal reduces percentage modulation in the receiver to very low values, as it increases the carrier response with respect to the sidebands. Hence under no circumstances is harmonic distortion likely to cause trouble in a quartz receiver. J. ROBINSON.

Mill Hill.

[In the article to which reference is made by Dr. Robinson above, it should be remembered that a specific problem, namely, the employment of a quartz crystal in conjunction with single-span tuning with an IF of 1,600 kc/s was under consideration. Some of the difficulties referred to in the article would not apply, or would apply to a lesser degree, with an intermediate frequency of lower value.

The value of the quartz crystal is now fully recognised, but its successful use in broadcast receivers having an intermediate frequency as high as 1,600 kc/s calls for further development, particularly in the case of receivers intended for home construction.—ED.]

Improving the Gramophone Record

MAY I suggest that the modern gramophone record lacks one very necessary improvement? I refer to the need of each record opening with an announcement of its contents.

How much more interesting and musical the home gramophone recital could be if devoid of the present interruptions of "What piece was that?" or "That was so-and-so, wasn't it?" The growing use of the record changer, when a dozen records may be put on, makes the matter urgent.

Not the least important function of a recorded announcement would be an accurate and pleasing pronunciation of difficult titles, composers' and soloists' names.

The method of presentation is debatable. I would suggest an abbreviated form of the recognised contents as printed on the present labels, arranged in a more suitable form; for instance, "The New Queen's Hall Orchestra, conducted by Sir Henry Wood, playing Mendelssohn's 'Fingal's Cave' Overture, Part I," and "Albert Sandler and his Orchestra, playing a waltz serenade, 'By the Sleepy Lagoon,'" should adequately meet the requirements of the majority.

A copy of this letter has been sent to one of the leading gramophone record-makers for their views on the suggestion.

New Barnet. N. MACKECHNIE.

The Invisible Man

WHILE we all respect Dr. Beatty as an arithmetician of the first order, and bless his Data Charts, he must not try to pose as a physicist.

He makes the delightful statement that, since H. G. Wells' invisible man was transparent, then he would be unable to absorb any radiant energy from the sunlight.

May I suggest that on the next sunny day Dr. Beatty feels the glass in one of his windows on the sunny side of the house?

I have not read "The Invisible Man" for some time, so it is possible that I have overlooked some vital evidence in support of Dr. Beatty's rash statement. One cannot, however, allow "transparency" alone to be sufficient argument for a complete absence of absorption in any part of the spectrum. S. FALLOON.

Southfleet, Kent.

I AM obliged for Mr. Falloon's interest in what is, perhaps, the most mysterious point in the researches of the late Mr. Griffin—the Invisible Man. The account which Mr. Griffin gave to Dr. Hemp is sadly incomplete, but he definitely stated that he had succeeded in decreasing the refractive index of his body till it was equal to that of air. Now, no solids or liquids known to chemistry have such a small refractive index, and the most plausible hypothesis seems to be that Mr. Griffin succeeded in stripping his component atoms of their outer shell of electrons, the shell which is responsible for all phenomena of refraction, reflection, and absorption of solar radiation. If this contention be granted it follows that he could be warmed only by contact with warm materials, such as air or clothing or soil, or by a warm bath.

It is most regrettable that no serious attempt has ever been made to recover Mr. Griffin's three note-books in which he recorded the details of his experiments. It is known that they were at one time in the possession of a Mr. Thomas Marvel, the proprietor of an inn somewhere in the Southern Counties. I have not the leisure to make inquiries myself, but if Mr. Falloon could be persuaded to make a pilgrimage to the various inns in that district he might possibly recover the priceless manuscripts. The expenses of the investigation might be borne jointly by the Royal Society and the Licensed Victuallers' Association.

R. T. BEATTY.

Asymmetric Sideband Broadcasting

YOUR article concerning my paper on asymmetric sideband broadcasting, recently read to the wireless section of the I.E.E., correctly reports the flavour of the discussion, but, in common with the major part of that discussion, appears to miss the root point brought out in the paper.

We all now agree that the distortions introduced in *single* sideband broadcasting prevent its use. Whatever form the explanation of the distortion phenomena may take, whether it is as "a B.B.C. representative" "explained" it—"the well-known difference which exists in the modulated envelope of single sideband as compared with double sidebands," or whether it is explained by the "well-known" equations or as perfectly clearly as it was in my paper—the effect unquestionably exists.

Once the reasons for the existence of distortion are understood, means for its suppression can be devised. The major purpose of my paper was to show that certain methods of cutting off spectrum did not introduce distortions. The systems I described are not, however, as everyone seems determined to believe they are, single sideband systems; they are, as the title to my paper indicates, asymmetric sideband systems.

Your account of the meeting leaves the impression that my paper had a possible value in provoking officialdom to become both articulate and informative, whereas I suggest it has the further merit that it sets out a possible solution to a difficult technical problem. P. P. ECKERSLEY.

London, S.W.3.

Fuses in Wireless Receivers

ABOUT a year ago I wrote to you respecting the lack of safeguards in commercial receivers for protecting the mains transformer in the event of short-circuits in the rectifier valve.

I expressed the view that fuses ought to be fitted in every set in order to prevent serious damage to the secondary transformer windings if a filament of a rectifier touched an anode. In the letter details of actual cases serviced by my firm were given.

Having had four cases of completely burnt-out transformers, due to faults in rectifier valves or smoothing condensers during the last fortnight, I am moved to address you again.

Why should the user be mulcted in the cost of an expensive transformer repair consequent upon another fault, which also involves expense, if such cost could be prevented by a simple addition to a receiver in the shape of a couple of small fuses? Many faults in receivers are due to causes unforeseen by the designers, but this one cannot be placed in that category. The protection of such apparatus as transformers is surely axiomatic in electrical design—it is an elementary precaution.

HILL-SMITH (WARRINGTON), LTD.,
R. W. Taylor, Director.

Warrington.